An assessment model for Enterprise Clouds adoption

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ABSTRACT

Context: Enterprise Cloud Computing (or Enterprise Clouds) is using the Cloud Computing services by a large-scale organisation to migrate its existing IT services or use new Cloud based services. There are many issues and challenges that are barrier to the adoption of Enterprise Clouds. The adoption challenges have to be addressed for better assimilation of Cloud based services within the organisation.

Objective: The aim of this research was to develop an assessment model for adoption of Enterprise Clouds.

Method: Key challenges reported as barrier in adoption of Cloud Computing were identified from literature using the Systematic Literature Review methodology. A survey research was carried out to elicit industrial approaches and practices from Cloud Computing experts that help in overcoming the key challenges. Both key challenges and practices were used in formulating the assessment model.

Results: The results have highlighted that key challenges in the adoption of Enterprise Clouds are security & reliability concerns, resistance to change, vendor lock-in issues, data privacy and difficulties in application and service migration. The industrial practices to overcome these challenges are: planning and executing pilot project, assessment of IT needs, use of open source APIs, involvement of legal team in vendor selection, identification of the processes to change, involvement of senior executive as change champion, using vendor partners to support application/service migration to Cloud Computing and creating employee awareness about Cloud Computing services.

Conclusion: Using the key challenges and practices, the assessment model was developed that assesses an organisation's readiness to adopt Enterprise Clouds. The model measures the readiness in four dimensions: technical, legal & compliance, IT capabilities and end user readiness for the adoption of Enterprise Clouds. The model's result can help the organisation in overcoming the adoption challenges for successful assimilation of newly deployed or migrated IT services on Enterprise Clouds.

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LIST OF ABBREVIATIONS

IT	Information Technology
ICT	Information and Communication Technology
Clouds	Cloud Computing
SaaS	Software-as-a-Service
PaaS	Platform-as-a-Service
IaaS	Infrastructure-as-a-Service
ITaaS	Information Technology-as-a-Service
ECAAM	Enterprise Cloud Adoption Assessment Model
SMEs	Small to medium-sized enterprises
OITIRS	Organizational Information Technology/Systems Innovation Readiness Scale
EHR	Electronic Health Records
EHR-ORT	Electronics Health Records - Organizational Readiness Tool
TCU-ORCA	Texas Christian University's Organizational Readiness to Change
SLR	Systematic Literature Review(s)
ERP	Enterprise Resource Planning
DOI	Diffusion of Innovation
TOE	Technological, Organisational and Environmental framework
HEI	Higher Education Institution
FEI	Further Educational Institution
ITSM	IT Service Management
COBIT	Control Objectives for Information and Related Technologies
ENISA	European Network and Information Security Agency
ISACA	Information Systems Audit and Control Association
SLA	Service Level Agreement
ITIL	Information Technology Infrastructure Library
UCISA	University Colleges Information System Administration
GUEG	Google Apps for Education European User Groups
CSA	Cloud Security Alliance's
CCM	Cloud Control Matrix

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To, the three women in my life
My mother, my daughter and my wife…

Chapter 1: Introduction

"All truths are easy to understand once they are discovered; the point is to discover them." Galileo Galilei

1.1 Context

In today's fast paced world, it would be not be possible for any large-scale organisation (Enterprise) to conduct its business without using Information Technology (IT). An Enterprise's strategic business units such as production, finance and marketing need support from Enterprise Information Technology department or Enterprise IT. Enterprise IT is a mixture of physical resources, logical structures of people and processes, applied to handle information, provide IT services, ensure access to business applications and manage IT infrastructure (Gartner Inc, 2011).

Ever changing business dynamics forces Enterprise to reduce capital expenditures and seek cost effective solutions in all aspects of its business including IT. The evolving Enterprise are now in need of new IT services that are adaptable, cost effective, highly available and with ability to scale up to demand (Creeger, 2009).

Cloud Computing (or Clouds) is considered as a technology that reduces cost, scale up or down resources as per need, provides innovative IT services with minimal investment (Armbrust *et al.*, 2010; Feuerlicht *et al.*, 2010).

Commonly, Cloud services are grouped by three services:

- Software as a Service (SaaS) are highly available, scalable and reusable software services, performing their functionality over the network, accessed mostly using web browsers (Javier, David & Arturo, 2008; Youseff, Butrico & Da Silva, 2008; Jaatun *et al.*, 2009; Mell & Grance, 2009)
- Platform as a Service (PaaS) enable consumers to develop applications and services offering application development environment, programming languages, tools and APIs (Mell & Grance, 2009; Gonçalves & Ballon, 2010)
- Infrastructure as a Service (IaaS) is computational resources, data storage and communication technology, hardware and operating system required to support PaaS and SaaS services (Geng *et al.*, 2009; Mell & Grance, 2009)

Cloud Computing is offered as Public Clouds which are third party services at a fee, Private Clouds that are deployed internally in data centers for private use or Hybrid Clouds which is a

composition of two or more than two Clouds for scalability needs (Mell & Grance, 2009). These deployment configurations (Public, Private and Hybrid) are the models of using Clouds by its consumers differentiated primarily on scope, access to services and management (Cáceres-Expósito *et al.*, 2010).

Enterprise Cloud Computing (or Enterprise Clouds) is a term that refers to, use of Cloud Computing for Enterprise IT services or deployment of Private Cloud on internal IT infrastructure or using Hybrid Cloud when required to scale the Private Cloud (Hinchcliffe, 2008; Kim *et al.*, 2009; Dwivedi & Mustafee, 2010; Bisong & Rahman, 2011).

Implementing or deploying Enterprise Clouds is a mean to provide software processing over Internet based services, utilizing infrastructures offered by Public Clouds or developing business applications on Platform as a Service. End user can deploy all of these services directly without the need of specialised IT support (Creeger, 2009). The technological abstraction offered by Enterprise Clouds to its end user enables them to focus on their work, work more collaboratively, adapting to market needs, while IT ensures smooth provisioning of service from vendors (Mulholland, Pyke & Fingar, 2010).

While IT department chooses the technology to deliver the IT services, the end user is expected to apply that particular technology in their work. User acceptance of technology is considered a personal preference and a social issue that can influence use of the technology (Davis, 1989; Venkatesh *et al.*, 2003). Researchers study new technology introduced in an organisation either by measuring users' perception or by studying the organisation as a whole. When it comes to Information technology that affects work environment, the second option of studying organisation is a dominant approach (Turner *et al.*, 2010). Many feel that users in a large-scale organisation would have to work with new technology even Cloud Computing regardless of their perception (Creeger, 2009).

Organisational adoption of a technology is its "implementation, routinisation and its assimilation" (Damanpour & Schneider, 2006; Wischnevsky, Damanpour & Méndez, 2010). This thesis takes Cloud Computing as an innovative technology being new and useful for Enterprise thus

when referring to Enterprise Clouds adoption, it means organisational adoption of Enterprise Cloud services (new services from Clouds or existing services migrated to Clouds).

Initiatives to introduce innovative technology services (i.e. Enterprise Clouds) directly impact on end user's working. These initiatives can result in successful organisational adoption or can fail. A failed implementation of any technology innovation in a large-scale company is loss of money, loss of reputation and loss of customer's trust (Koch, 2002). A recent commercial survey reported that 150 large-scale firms in UK collectively had spent, an average of more than nearly £138,000 a year over the past five years, on fixing their Cloud services to make them effective (Sungard AS, 2015). Better understanding of technology, complexities of the Enterprise's structure, intricacies of people involved and being better prepared for the innovation could avert disasters like that.

This thesis is a yield of research work carried out to extensively explore adoption issues of Enterprise Clouds. However, it not only studies adoption challenges, this work empirically collected industrial practices suggested by IT practitioners who have experience in implementation of Enterprise Clouds. The solution of overcoming the challenges in adoption of Enterprise Clouds is to bring readiness in the organisation such that the services offered by Enterprise Clouds are routinized and assimilated.

1.2 Research Motivation and Objectives

The overarching aim of the research study was to develop a model that can assist organisations in assessing their readiness for adoption of Enterprise Cloud. To achieve the aim the following objectives were identified:

i. Identify the challenges that are barrier in adoption of Enterprise Clouds.

Several earlier research work had focused on identifying issues of adoption of Cloud Computing in Small and Medium scale organisations (Kim, 2009; Chinyao, Yahsueh & Mingchang, 2011; Alhammadi, Stanier & Eardley, 2015; Doherty, Carcary & Conway, 2015; Vidhyalakshmi & Vikas, 2016) and reported issues as Internet connectivity concerns, Security concerns and issues, Lack of trust in Service provider, Cloud availability issues, Vendor lock-in concerns, Data protection

concerns, Compliance concerns, Data security, network security, data access, data confidentiality, interoperability and vulnerability of virtualization.

Adoption issues of a large-scale organisation with Enterprise IT are different from small-scale organisations (Kim *et al.*, 2009). Cloud services when implemented within a large-scale organisation face multidimensional issues that could be Financial, Technical, Operational and Organisational issues (McKinsey Co, 2009).

Xin & Levina (2008) studied adoption of Enterprise Clouds and reported technological uncertainty, demand uncertainty for (software) functionality, number of users, institutional influence, strategic importance of the IT application and Enterprise IT architecture maturity as issues. On the same note, Kim *et al.* (2009) reported application integration and legal compliance as barriers.

Yanosky (2008) discussed impact of Enterprise Clouds on the authority of the IT department and change in IT governance, IT provisioning, IT procurement and IT policies. The extent of the organisational change associated with the adoption of Clouds were a cause of concern as it would impact accounting, security, compliance, project management, work of end users, effectively all aspects of an organisation (Greenwood *et al.*, 2010).

Heinle & Strebel (2010) focused on adoption of Infrastructure-as-a-Service (IaaS) within Enterprise and reported that lack of clarity of IaaS, absence of innovation champions within the IT departments, difficulties in cost-benefit evaluation of IaaS services, fear of organisational change and issues in Cloud Vendor selection are challenges that are inhibiting adoption.

However, these and several other publications reviewed, proposed either no solution or lacked empirical evidence to support their views. *This necessitated further exploration of the challenges that are barrier in adoption of Enterprise Clouds and seek solution to the challenges.*

ii. Industrial practices provide better solution to problems and should be studied.

Exploring industrial practices in overcoming the challenges was motivated by suggestion of Davis & Hickey (2002), who states that many *researchers fail to understand the current industrial*

practices, thus any solution they propose would not be applicable to industry. Technology adoption literature argues that organisation's capabilities have an impact on adoption of any particular technology (Chen, 1996). One approach to overcome issues in technology adoption is to develop organisational capabilities (Chen & Tsou, 2007). Organisational capabilities are set of processes the helps organisation achieve its objective by take advantage of internal and external resources (Chandraskaren & Balaji, 2007). Thus, a way to overcome the challenges in adoption of Enterprise Clouds would be to develop capabilities, identify actions and change processes that can help in successful implementation. *This motivated to look for solution to adoption issues and know about industrial practices*. A survey of IT Managers and IT consultants with experience in implementing or adoption of Enterprise Clouds was conducted out to elicit best practices or lessons learned.

iii. Assessing organisational readiness to adopt Enterprise Clouds

Cloud vendors such as Hewlet Packard (HP), IBM, Google and Microsoft are aggressively pushing Enterprise Cloud Computing services. The vendors' offer advisory services and their own proprietary approaches that help in implementing Cloud services. IBM's proprietary framework Cloud Computing Adoption Framework (IBM, 2010) defines a visual roadmap for Cloud adoption, roles and responsibilities. These vendor-led advisory services lack neutrality and promote vendor lock-in hence there is a need for independent and impartial advice, tools and techniques for the adoption of the Clouds. Research work suggesting vendor neutral solutions counter vendor-lock in and promote open standards (Neal, 2009).

Assessing an organisation's ability to implement any particular innovation is referred as "organisational readiness". Several studies have developed organisational readiness assessment tool/instruments. Existing work such as Organizational Information Technology/Systems Innovation Readiness Scale (OITIRS) (Snyder-Halpern, 2002), Electronics Health Records - Organizational Readiness Tool (EHR-ORT) (Cherry & Owen, 2008), Texas Christian University's Organizational Readiness to Change (TCU-ORC) (Lehman, Joe & Simpson, 2002) measures an organisation's readiness to implement new IT initiatives. However, when critically appraised, these existing models were found not able to assess an organisation adopting Enterprise Clouds. *This motivated to*

develop a new model, to measure the organisation's readiness in overcoming the challenges in the adoption of Enterprise Clouds.

To achieve these objectives following research questions were investigated:

RQ1: What are the key challenges in the adoption of Enterprise Cloud Computing?

RQ2: What are the industrial approaches or practices or capabilities that can help in overcoming the adoption challenges of Enterprise Cloud Computing?

RQ3: How an assessment model measuring organisational readiness for adoption of Enterprise Cloud Computing can be developed?

To answer the above given research questions, mix methods (quantitative and qualitative) were used for data collection and development of the assessment model. Existing literature was systematically reviewed to identify the challenges in the adoption of the Enterprise Clouds and a survey collected the experiences of IT practitioners. This work has proposed new capabilities, processes and practices that can help in successful adoption of Enterprise Clouds. This is an effort to narrow the gap between Cloud Computing research and practice by presenting a theoretically and practically robust model for the adoption of the Enterprise Cloud Computing.

1.3 Thesis Contributions

This thesis contributes to the existing body of knowledge in the following ways:

- Identification of key challenges in adoption Enterprise Clouds

The first task in research was to identify the challenges that are barrier in the adoption of Enterprise Clouds. To identify the challenges a systematic literature review (SLR) was carried out on publications in Software Engineering, Cloud Computing, Technology Adoption & Organisational Assessment areas, following the well-established guidelines by Kitchenham & Charters (2007). Literature reviews are inherently biased, where as SLR ensure that biases in selection of publication are minimised (Brereton *et al.*, 2007). Comprehensive and repeatable automated search, critical appraisal of all publication included in SLR data set, using second reviewer to verify and validate data extraction and thematic synthesis helped in minimising the selection and review biases.

Investigation and analysis of the state of the art, led to the challenge in the adoption of Enterprise Cloud Computing. The challenges reported in literature were categorised into issues and concerns: Concerns about availability, reliability and data privacy of Clouds, Security concerns, incompatibility of existing IT Infrastructure for migration to Clouds, excessive effort is required to re-engineer legacy applications, end-users' resistance to change, changes in IT work pattern, IT staffs' resistance to change, loss of internal expertise, change in IT Dept.'s authority and issues with increased dependence on a third party provider. Several newer challenges unique to Enterprise environment have been identified, drawing distinction between issues in Cloud Computing and Enterprise Clouds.

To best of my knowledge and belief, *there has not been an existing study or review with such comprehensive coverage on the topic*. This study varies from previous works i.e. Xin & Levina (2008), Benlian & Hess (2011) and (Heinle & Strebel, 2010) as 1) this categorically focuses on Enterprise Clouds and its issues and 2) focuses on whole Clouds, not a single Cloud service i.e. First two focus on SaaS and last one on IaaS.

- Industrial practices that can help in overcoming issues in adoption of Enterprise Clouds

During this study, a survey research was carried out that targeted Cloud deployment experts, Cloud App Trainers, Cloud App developers, IT Experts, IT Managers or ICT Support Staff (referred as IT practitioners) who have migrated or deployed IT services on Cloud Computing within their organisations or at client organisations.

The questionnaire sought their opinions and information the practices they have used in overcoming the challenges in deployment of Enterprise Clouds. The practices such as using open source APIs to access Cloud services, involvement of legal team in vendor selection process, identification of the workflows/processes to change, involvement of senior executive as change champion, using Re-seller/Vendor partners support for application/service migration to Clouds and develop Cloud service quality feedback mechanism etc.

These practices are taken as industry preferred practices that can overcome specific challenges in adoption of Enterprise Clouds. The practices shared by IT practitioners add quantitative and quantitative data to the body of knowledge, which is novel in its nature.

- Developed an organisational assessment model for adoption of Enterprise Clouds

The formulation of the solution to overcome the challenges in adoption of Enterprise Clouds resulted in, Enterprise Clouds Adoption Assessment Model (ECAAM). ECAAM helps an Enterprise in assessing its readiness to overcome the adoption challenges. The model ECAAM is designed as a self-analysis assessment tool, easy to use, that gives the evaluator easily interpretable results. The ECAAM is unique in comparison to other readiness assessment frameworks/tools (discussed earlier in Sec 1.2, OITIRS (Snyder-Halpern, 2002), EHR-ORT (Cherry & Owen, 2008), TCU-ORC (Lehman, Joe & Simpson, 2002) because its assessment constructs are drawn from empirically validated challenges in adoption of Enterprise Clouds and practices that help in overcoming the challenges.

ECAAM assesses the organisation in four organisational dimensions 1) Technical readiness, 2) Legal & Compliance readiness 3) IT Capabilities readiness and 4) End users readiness. This model helps in identifying the state of organisational readiness in Infrastructure, People and Processes.

ECAAM helps in successful adoption of newly deployed/migrated IT services on Enterprise Clouds, thus a contribution of this work, adding to existing Cloud Computing body of knowledge.

1.4 Thesis structure

The thesis has been organised to into six chapters. Following is the overview of the contents of each chapter:

- Chapter II: Back ground & Research Design

Chapter 2 discusses the background of the problem and research strategy used in answering the research questions. It presents steps in problem identification, data collection and proposed solution. A section compares various research methods including the Systematic Literature Review and Research Survey. These two methods have been recommended for developing the evidence-based body of knowledge that was used to formulate the Enterprise Cloud Adoption Assessment Model (ECAAM).

- Chapter III: The SLR Design & Results

The Systematic Literature Review (SLR) was used as a data collection strategy to extract primary data from the existing literature. This chapter describes the initial search piloting, formulation of search strings, execution of search on data sources, data extraction, review of reported studies and application of thematic synthesis to analyse data extracted from literature. The chapter concludes with a discussion of validity threats and introduces the next phase of data collection.

- Chapter IV: Survey Design, Results & Discussion

This chapter presents the objective of the survey for this research, questionnaire design, sampling and dissemination of the survey questionnaire to target respondents. The results from this survey are analysed and presented on this chapter. Results will include key adoption challenges of the Enterprise Clouds and the industrial approaches for overcoming the challenges.

- Chapter V: Enterprise Cloud Adoption Assessment Model (ECAAM)

This chapter presents the Enterprise Clouds adoption model based on the findings from the SLR (Chapter 3) and the Survey (Chapter 4). The model draws its assessment constructs from the literature, SLR's and survey results and from other assessment models. An evaluation of this model in industrial settings is also presented.

- Chapter VI: Conclusion

This chapter concludes the finding of the thesis. It also discusses the implication of the thesis on research and practice. Finally, it suggests the further work to be carried out.

Chapter 2: Background & Research Design

Introduction

This chapter discusses the background of the problem of adoption Enterprise Clouds and research strategy used in answering the research questions. It details the problem, its data collection and the theoretical underpinning of the proposed solution. The section on research strategy describes in details the research design, phases and mix methods involved in answering the research questions presented in previous Chapter. One sub-section in this chapter justifies the use of research methods including the Systematic Literature Review and Research Survey, applied to answer the research questions. These two methods have been used in developing the evidence-based body of knowledge, which was later used in formulating the Enterprise Cloud Adoption Assessment Model (ECAAM).

2.1 Background

2.1.1 IT innovation and Technology adoption

Information Technology (IT) innovation in an organisation is described as use of Information Technology in a "new" way to support new goals or to bring efficiency in organisation. The initiatives to introduce new IT technology can take several forms i.e. changes in existing IT services, deployment of new services etc. or introduction of new work technology.

An analysis of annual "Gartner Hype Cycle for Emerging Technologies report" over last five-years reveal that several new technologies have emerged with potential applicability in business world and are being introduced in organisations (Fenn, Gammage & Raskino, 2010; Gartner Inc., 2016). These new technologies in year 2010 included Cloud Computing, Augmented Reality, Tablets, Wireless power and in year 2016 the latest technologies are Virtual personal assistants (Siri, Cortecna etc.), Cognitive Expert advisors, Commercial Drones for logistical support etc. (Fenn, Gammage & Raskino, 2010; Gartner Inc., 2016).

Cloud Computing was part of Gartner Hype Cycle in year 2006 and from that point the hype has seen an increasing trend, with increase in internet chatter, patents and paper publications (Adamuthe, Tomke & Thampi, 2015).

The emergence of new technology would perhaps never stop, as inventors would keep inventing. However, the question remains which of these new technologies are being adopted successfully in organisations.

Damanpour & Schneider (2006) describe “successful application of a product or process by a potential organisation” as organisational adoption. Makkonen (2008) summarised the process of organisation adoption of an innovation is: initiation and adoption, where adoption includes implementation, routinisation and assimilation of technology.

For individuals working in an organisation multiple factors influence technology up-take i.e. technology’s characteristics and perceived benefits (Mehrtens, Cragg & Mills, 2001). The individual factors are studied using many theories such as Technology Acceptance Model (TAM) (Davis, 1989), TAM’s variant Unified theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) etc. Many critics of TAM are of the view TAM and its variants are best suited for individual level of analysis and it should not used to measure firms’ or organisational adoption (Hsu, Kraemer & Dunkle, 2006; Oliveira & Martins, 2011).

For organisation level of assessment, Diffusion of Innovation (DOI) (Rogers, 1995), and the Technological, Organisational and Environmental framework (TOE) (Tornatzky & Fleischer, 1990) are used as they both are best suited for organisational level assessment of innovative technology adoption (Oliveira & Martins, 2011).

Diffusion of Innovation (DOI) theorises the ways new ideas and technology spreads through an organisation and individuals associated with it (Rogers, 1995). The focus of DOI theory is on individual as it sees their willingness to adopt innovations and segregates them into five categories, terming earliest to adopt as innovators, early adopters, early majority, late majority and laggards (Rogers, 1995).

Technology, Organisation and Environment Context (TOE) talks of three aspects of an Enterprise's context that influences the process of technology implementation and adoption (Tornatzky & Fleischer, 1990). The three contexts are technological context, organisational context, and environmental context. Technological context describes both the internal and external

technologies relevant to the firm, organisational context refers to descriptive measures about the organisation and environmental context is the environment in which a firm conducts its business (Tornatzky & Fleischer, 1990).

Zhu, Kraemer & Xu (2006) used the TOE framework to understand organisational adoption of E-Business. They carried out a survey of 1,857 firms across 10 countries and identified that technology readiness and integration, structure, technological capability and firm's size are critical factors for adoption of E-business.

Kouki, Poulin & Pellerin (2009) carried out a study of technology innovation in a large-scale organisation to study Enterprise Resource Planning (ERP) system's adoption using TOE. They identified that technical factors that influence adoption of ERP pointed out several factors that are barrier to adoption of ERPs (Kouki, Poulin & Pellerin, 2009).

The following table (See Table 1) summarises the challenges in adoption and assimilation reported in reviewed literature.

Table 1 Challenges in technology adoption & assimilation

Contexts	Challenges in adoption and assimilation of technology
Technical Context	Lack of ability to integrate technology with existing resources (Zhu et al., 2006)
	Technology integration within existing technological resources (Zhu, Kraemer & Xu, 2006)
	Lack of technology readiness (Zhu, Kraemer & Xu, 2006)
	Lack of financial/other resources for technology implementation (Oliveira & Martins, 2010)
	Concerns about reliability of technology (Lippert & Govindarajulu, 2006)
Organisational Context	Organisation not ready and aligned to uptake the technology, Processes not yet aligned (Hsu, Kraemer & Dunkle, 2006)
	Complexity of organisational structure (Hsu, Kraemer & Dunkle, 2006)
	Size of organisation could be a hurdle(Zhu et al., 2006; Zhu, Kraemer & Xu, 2006)
	Lack of capabilities within for that technology (Lippert & Govindarajulu, 2006)
	Managerial obstacles (Zhu, Kraemer & Xu, 2006)
	Users resistant to change (Kouki, Poulin & Pellerin, 2009)
Environmental Context	Competitors are adopting technology (Hsu, Kraemer & Dunkle, 2006) Pressure from industry (Lippert & Govindarajulu, 2006; Zhu, Kraemer & Xu, 2006)
	Government forcing to use technology (Hsu, Kraemer & Dunkle, 2006)
	Regulatory compliance/Regulatory pressure (Lippert & Govindarajulu, 2006; Zhu, Kraemer & Xu, 2006)
	Partners are forcing to use technology (Lippert & Govindarajulu, 2006)
Others	Technology – Firm misfit (Zhu et al., 2006)
	Perception of benefits and extensive hurdles in adoption (Hsu, Kraemer & Dunkle, 2006)
	Comparing technology with its alternatives (Zhu et al., 2006)
	Security concerns (Hsu, Kraemer & Dunkle, 2006; Lippert & Govindarajulu, 2006; Zhu et al., 2006)

2.1.2 Adopting Enterprise Clouds

From the business perspective, Cloud services are fundamentally not a new concept as it originates from much developed concepts of web services, e-business etc. Technology adoption challenges drawn from e-business would relate to Cloud Computing as both technologies have several commonalities i.e. Internet, Dependency on vendors etc.

Chinyao, Yahsueh & Mingchang (2011) used TOE to determine influencing factors for Cloud Computing adoption in Taiwanese industry. The factors that influence organisational adoption are: relative advantage, complexity, and compatibility as technological context, top management support, firm size and technology readiness as organisational context and competitive and trading

partner pressures as environmental context. They acknowledge weakness of their work that these factors may not be generalizable due to lack of diversity in firms that were part of their sample.

Oliveira, Thomas & Espadanal (2014) conducted a study on facilitating factors of Cloud Computing adoption using DOI and TOE's constructs. The data was collected from 369 firms in Portugal from the manufacturing and services sectors. Their results show that five factors that influence the adoption of Cloud Computing are: relative advantage, complexity, technological readiness, top management support, and firm size.

Doherty, Carcary & Conway (2015) studied Cloud Computing drivers and barriers of adoption in the context of the small to medium-sized enterprises (SMEs) in Ireland. A survey of 95 SMEs indicated that the key drivers in adoption of Cloud Computing in Irish SMEs is the cost benefits and the key challenge that is barrier to the adoption is the availability concerns of Cloud service.

Xin & Levina (2008) explored Software-as-a-Service (SaaS) adoption within Enterprise with multiple theories and pointed out several adoption factors: technological uncertainty, demand uncertainty for (software) functionality, number of users, institutional influence, strategic importance of the IT application and Enterprise IT architecture maturity.

Heinle & Strebel (2010) conducted interviews using the DOI, Agency Theory and IT Governance theory's constructs to highlight the adoption factors for Infrastructure-as-a-Service (IaaS) in Enterprise. Adoption factors are: clarity about IaaS, presence of innovation champions within the IT departments, cost benefit evaluation and current IaaS offerings are facilitating factors. Inhibiting factors include fear of organisational change, issues in vendor selection and incompatibility of IaaS service (Heinle & Strebel, 2010).

2.1.3 Assessing organisation

One gap, that was visible in reviewed literature was that several studies i.e. Hinchcliffe, 2008; Xin & Levina, 2008; Creeger, 2009; Helfrich et al., 2009; Kim et al., 2009; McKinsey Co, 2009; Heinle & Strebel, 2010; Wu, 2011; Wu, Lan & Lee, 2011, pointed out barriers in adoption of Enterprise Clouds but give limited suggestions to overcome those barriers. In most cases suggestions are without any empirical evidence.

Building on earlier notion that "Enterprise Clouds is an IT innovation" a suggestion by Christensen & Overdorf (2000) seemed appropriate as one way to overcome the barriers in adoption of innovation is that Managers must assess their organisation has the "ability to embrace the innovation" as this help them "understand what their organisations are capable of accomplishing" (Christensen & Overdorf, 2000).

Organisational assessments are review of an organisation's processes, its work environment and organisational structure, carried out by Human Resource Manager at regular intervals or before/after a new structural change (Ulrich *et al.*, 2008). It would become necessary for IT Manager to assess organisational capabilities on introduction of new IT innovation. The results of this assessment can help in identification of barriers to adoption, associated risks, challenges, concerns and legal issues. Carrying out an assessment would give Project manager better understating once decision is taken.

The assessment can measure organisational readiness for that innovation, identifying the gaps in current resources, processes that must be aligned to the newly introduced innovation. Organisational readiness is defined as the "willingness and the ability to implement any particular innovation" (Weiner, Amick & Lee, 2008). This view of "organisational readiness" is in two parts 1) the willingness to implement 2) the ability to implement.

Weiner (2009) sees organisational readiness in terms of employee's psychological beliefs, their attitudes and intentions as willingness to implement innovation. Nevertheless, employees are not alone in implementing the innovation, as the organisational processes, infrastructure and resource all work in tandem towards organisational goals.

Another aspect of organisational readiness is “readiness for change” or “change readiness”. For an organisation, introducing an innovation that would bring change in its work, structures, processes or strategies would require successful implementation of the proposed change. Staff behaviour is a critical success factor for the change’s implementation as the effort to change can either be resisted or supported by the staff (Armenakis, Harris & Mossholder, 1993). Organisational readiness for an innovation is by definition “organisational readiness for change” (Weiner, Amick & Lee, 2008). Assessing or measuring readiness is an essential task while implementing the change (Armenakis, Harris & Mossholder, 1993). They stress on carrying out a “readiness assessment”, which would help in guiding the implementation efforts and assess overall readiness.

Several researchers have focused on measuring organisational readiness for IT innovation or Change.

Organizational Information Technology Innovation Model (Snyder-Halpern, 2001) provides IT decision makers in health care organisations with an organisational assessment framework. The framework defines several dimensions/factors that influence the project implementation (Snyder-Halpern, 2001). The dimensions are External environmental factors, Health care organisation characteristics and Information technology innovation readiness (Snyder-Halpern, 2001). Seven innovation readiness sub-dimensions were identified for the model. The readiness sub-dimensions are: resources readiness, staffing & skills readiness, technology readiness, knowledge readiness, process readiness, values & goals readiness and operational readiness (Snyder-Halpern, 2001). After a Delphi study, that resulted in collection of readiness indicators from IT professionals who were members of Healthcare Information and Management Systems Society, an Organizational Information Technology/Systems Innovation Readiness Scale (OITIRS) was developed (Snyder-Halpern, 2002). The definitions of the sub-dimensions in the OITIRS Readiness are in the following table (See Table 2). The table is an extract of the table from Snyder & Fields (2006).

Table 2 OITIRS Sub-dimensions (Snyder & Fields, 2006)

Organisational Information Technology Innovation Readiness Scale Sub-dimensions	
Sub-Dimensions	**Definitions**
Resources	IT innovation support mechanisms
End-Users	User characteristics and profile
Technology	IT infrastructure
Knowledge	Past and current IT innovation decisions
Processes	Operational and work processes that influence IT innovation
Values & Goals	Individual & organisational IT values and goals
Management Structures	Organisational & operational structures influencing IT innovation
Administrative Support	Leadership style and practices that influence IT innovation

Table extracted from Snyder and Fields (2006) Table 1

Forty-eight items are part of readiness measurement instrument that has a Likert-type response format with 1 (strongly disagree) to 7 (strongly agree). A total OITIRS score is sum of all 48 items and it is interpreted as, higher OITIRS score means greater perception of organisational readiness to support IT innovation (Snyder-Halpern, 2002). A multi-site study on a much larger group of respondents validated the scale items (Snyder & Fields, 2006). Google Scholar's bibliography survey points out that this work has been cited by 22 publications and used to assess technology adoption in healthcare.

Cherry & Owen (2008) developed a readiness assessment tool to measure organisational readiness & success factor for technology adoption in health care settings. The tool is named as "Electronics Health Records - Organizational Readiness Tool" (EHR-ORT). The tool measures successful implementation of Electronic Health Records in long-term care provider organisations. The research was carried is out in three phases, a systematic literature review (SLR) was carried out to identify factors that facilitate implementation of Electronics health records, Focus groups where conducted with industry professionals and then EHR-ORT was developed (Cherry & Owen, 2008; Cherry, 2011). Building on the facilitating factors in organisation, EHR-ORT measures organisational readiness in 6 readiness areas tabulated below (See Table 3).

Table 3 EHR-ORT Readiness areas (Cherry and Owen, 2008)

Electronics Health records - Organizational Readiness Tool for Licensed Nursing Facilities	
Readiness areas for successful implementation*	
Readiness Areas	**Facilitating Factors/Dimensions**
Organisational culture/human factors	Leadership support
	Congruence with organisational mission and strategic goals
	Employee attitude and engagement
Financial aspects	Financial resources for start-up, training and on-going costs
Implementation processes/staff training	EHR products that meet specific needs
	Leadership and expertise for project implementation
	Implementation planning with cross-departmental representation and processes related to paper record conversion, staff buy-in, and training
Evidence that systems will improve care	Outcome evaluation plan
State regulatory support	State regulatory survey team support
Technical requirements	Technical support
	Physical space and physical plant requirements

*Reported in Cherry and Owen (2008)

In each area, there are statements to which a respondent has to respond the extent of their agreement or disagreement, using a 7-point Likert-type scoring model (Cherry & Owen, 2008). Cherry (2011) used the scoring mechanism from the OITIRS (Snyder-Halpern, 2002; Snyder & Fields, 2006), hence the tool's interpretation is somewhat same as OITIRS, higher the total score greater the perception of respondents on the readiness and ability to successfully implement the Electronics Health Records within their organisation.

Texas Christian University's Organizational Readiness to Change (TCU-ORC) is an readiness assessment tool that measures motivation readiness of leaders and staff, resource readiness, and organisational climate readiness to implement new technologies (Lehman, Joe & Simpson, 2002). TCU-ORC is based on previous research work of technology implementation process (Simpson, 2002) within healthcare agencies.

Lehman, Joe & Simpson (2002) consider that technology implementation leads to change, thus, there is a need for change readiness in organisation as whole and people in particular. TCU-ORC has 115 Likert-type items, scored on a 5 point agreement-disagreement scale by respondents, in four major areas: motivation for change, institutional resources, personality attributes of the staff and organisational climate (Lehman, Joe & Simpson, 2002) (See Table 4).

Table 4 TCU- ORC Readiness Areas (Lehman, Joe & Simpson, 2002)

Texas Christian University - Organisational Readiness to Change Assessment		
Change readiness in Areas		
Readiness Areas	**Sub-areas**	**Definition**
Motivation for Change	Program Needs for Improvement	Reflection of valuations made in a program about its strengths and weaknesses.
	Immediate Training Needs	Need for training for staff
	Pressures for Change	Internal or external pressure for change
Adequacy of Resources	Offices	Adequacy of office and physical space available
	Staffing	Number and quality of staff members available to do the work
	Training	Management and financial support for staff training and development
	Equipment	Adequacy and use of computers
	Internet	Use of e-mail and the Internet for professional communications, networking, and information access.
Staff Attributes	Growth	Extent to which the staff values and perceives opportunities for professional growth
	Efficacy	Staff's confidence in their own job skills
	Influence	Willingness and ability of a staff member to influence co-workers
	Adaptability	Ability of staff to adapt to a changing environment
Organizational Climate	Mission	Staff awareness of organisations mission and management emphasis on goals.
	Cohesion	Work group's trust and cooperation
	Autonomy	The latitude staff are allowed in their working
	Communication	Management receptivity to suggestions from staff and the adequacy of information networks to keep everyone informed.
	Stress	Perceived strain, stress, and role overload
	Change	Management's interest and efforts in keeping up with change

Text taken from Lehman, Joe & Simpson (2002)

Thought, TCU-ORC's measures are using staff's insights and viewpoints yet it is recommended that these measures/items should vary for respondents based on their level of responsibility within organisation. Lehman, Joe & Simpson (2002) used this measure on Directors and staff within organisations, then compared similarities and differences in responses analysing how both groups view their organisation. One limitation of TCU-ORC is that the internal reliability measures of each item are taken on samples drawn on program level (departmental in business context), which can vary when values are taken across an organisation. TCU-ORC's assessment does not offer a single "ready" or "not ready" interpretation as compared to previous tools measuring readiness (Snyder-Halpern, 2002; Cherry & Owen, 2008), rather it describes situations in

organisation where change is not occurring and identifies the barriers (Lehman, Joe & Simpson, 2002).

After reviewing the organisational assessment models, one approach to develop the indicators/scales for assessment was to identify the capabilities within organisation to adopt or implement innovation or change. Organisational capabilities are resources, people and set of processes the help an organisation achieve it objectives (Christensen & Overdorf, 2000; Chandraskaren & Balaji, 2007).

Ross, Beath & Goodhue (1996) cluster IT capabilities as management of three key IT assets 1) competent IT staff (People) 2) technology (IT infrastructure) and 3) strong relationship between IT and business management (IT processes). Chen & Tsou (2007) argue that organisation's capabilities have an impact on adoption of new technology, as organisation has to either acquire or define new capabilities. In simple words, organisation would have to increase its capability to overcome the barrier in adoption of new technology.

Learning organisations tend to explore and use best practices to implement or deliver new services (Ulrich *et al.*, 2008). The commonly used term "best practices" or "industry preferred practice" refer to a set of solutions to commonly faced problems. Generally, "best practices" is a set of methods or techniques that are considered more effective than other available sets or techniques, or methods/techniques used or because it has perhaps become a standard way of doing things. However, there is no consensus on what are the industrial preferred practices but commonly the practices that are adopted by a particular industry or preferred by practitioners in industry, with applicability to issues unique to its own industrial context are termed as industrial practices.

Like other industries, Software development industry has its own practices such as design patterns, which is solution to commonly occurring problems encountered while designing software. Applying Design patterns is an industry-preferred practice in solving design issues. Software Engineers or IT Practitioners tend to either seek solutions to their problems from research or gain it from experienced peers, while considering the effectiveness of the solution.

Cloud Computing is new mechanism of IT service delivery and its adoption would enhance IT capabilities (in people, in infrastructure and in processes) within organisation. Cloud Computing services when used in large-scale organisation would pose multi-dimensional challenges. There is need for practices that can help in overcoming these challenges for adoption of Enterprise Clouds as a technology.

The literature review led to need of developing a new model using same theoretical foundations as the reviewed organisational assessment models. Hence, it was decided to propose a model that can to assess organisation readiness to overcome the barriers in the adoption of Enterprise Clouds.

The following table (See Table 5) summarises the critical review of the models reviewed with comments on their scales and constructs.

Table 5 Critical appraisal of existing assessment models

Critical appraisal of organisational readiness assessment framework/model		
Model	**Aims**	**Comments**
Organizational Information Technology Innovation Readiness Scale (OITIRS) (Snyder-Halpern, 2002)	Measures organisational readiness to assess readiness for Information Technology innovation in organisational dimensions	• OITIRS measures readiness for IT Innovation but it cannot be applied to measure an organisation adopting Enterprise Clouds because: o Some of the items are very specific to healthcare settings and modifying them is not possible. o Its sub-dimensions makes item-sub dimension mapping difficult, do not segregate items in OITIRS. The scoring is collective. o OITIRS ignores organisational characteristics (existing IT resources, hardware etc.) and external environmental factors (regulatory compliance etc.), both of which are very important in Cloud Computing. • Some of its indicators can be used in Enterprise context with modification. • The scoring mechanism can be used
Electronics Health Records - Organizational Readiness Tool (EHR-ORT) (Cherry & Owen, 2008)	Measures organisational readiness in functional areas assessing the factors to overcome issues in Electronic Health Record implementation	• The EHR-ORT is developed on solid empirical foundation • Drawbacks of EHR-ORT are: o EHR-ORT is not customizable or modifiable to be used for Cloud Computing or Enterprise Clouds, as the items are specific to Electronic Health Record (EHR) as technology. o This model segregates items by areas yet some areas are specific to health care industry. o In Cloud Computing, there is external pressure to comply with regulations especially in Enterprise (Kim, 2009) where as in EHR external support is provided by regulatory team.
Texas Christian University Organizational Readiness to Change (TCU-ORC) (Lehman, Joe & Simpson, 2002)	Measures organisational change readiness in four dimensions.	• Most of the TCU-ORC's assessment cannot be modified or used directly for assessment of Enterprise Clouds adoption because item scales are very specific to change readiness. • Implementation of Enterprise Clouds has its technical needs, capabilities needs and any other special needs that are not measurable using this model. • Change readiness is one part of Cloud Computing implementation within an Enterprise, thus some of its scales relater to staff and organisation change readiness can be used.

2.2 Empirical Research Design

Empirical research is the type of research that explores, describes, predicts and explains, "natural, social, or cognitive phenomena" using observation or experience (Dag, Tore & Magne, 2007). Although, the approach to research is dependent on the context, but mostly the steps involved in empirical research are: formulating the research questions, observing the situation, summarizing the observation into data, analysing the data and finally drawing conclusions with respect to the research question (Dewayne, Adam & Lawrence, 2000). Regardless of the steps or the questions, the real spirit of the empirical research is to learn something useful by comparing theory to reality, resulting in enrichment of theories (Dewayne, Adam & Lawrence, 2000).

2.2.1 Empirical Research in Software Engineering

Software Engineering (SE) is a socio-technical field, with much emphasis on the software engineer, the human being involved in its complex processes (Easterbrook *et al.*, 2008). Besides, developing an understating of the technical processes, the researchers have to understand the individual and groups' social and cognitive processes within the organisational context (Creswell, 2009). Software Engineering as a discipline has adopted "empiricism" because it has helped in building theories and providing better knowledge of individual and organisation (Wohlin, Höst & Henningsson, 2003). The researchers are suggested to "embrace empirical methods" due to their suitability for the software engineering research (Wohlin, Höst & Henningsson, 2006).

Either qualitative or quantitative methods can be applied for an empirical research to collect and analyse data. The qualitative method collects numerical data and then analyses it using statistical methods, while quantitative method collects facts in multiple forms (text, images etc.) and use data analysis techniques that do not require precise measurements (Dewayne, Adam & Lawrence, 2000). For a researcher, both methods provide ample opportunities to analyse the data but the quantitative techniques gives more opportunities for data comparison due to the presence of numerical data (Wohlin, Höst & Henningsson, 2006).

There are several guidelines to help budding researchers in selecting an appropriate approach to their research in Software Engineering. These guides provide an insight to the commonly used methods applied in SE research. The empirical techniques more appropriate and relevant to SE are controlled experimentation, surveys, case studies, action research, post-mortem analysis, systematic reviews etc. (Kitchenham *et al.*, 2002; Wohlin, Höst & Henningsson, 2003; Wohlin, Höst & Henningsson, 2006; Dag, Tore & Magne, 2007; Easterbrook *et al.*, 2008).

The question of applying the most appropriate method does arise but there is no single formula that can help in developing a research strategy or selection of appropriate empirical method (Easterbrook *et al.*, 2008). The selection and application of an empirical method in a doctoral research is a difficult task. The PhD study is constrained by time, resources, poor support from industry and limited skills of the student. Perhaps all PhD students prefer the most commonly applied methods because they find readily available help to apply them.

2.2.2 Research strategy

For this research, the choice to use empirical approach was made on two crucial considerations:

1) the exploratory nature of the research questions and

2) the accessibility to the real world insight offered by the techniques.

This section discusses in detail the research design decision taken and their justifications. This study design combines multiple techniques, for data collection, validation and model development. Kitchenham *et al.* (2002) suggest a mix of qualitative and quantitative methods for SE research, as both methods are complementary. Thus, in this research a combination of qualitative and quantitative methods was used.

The study design follows three distinct phases, first is problem definition, data collection and analysis and last is model development. The figure represents the research design, its phases and outcomes of each phase.

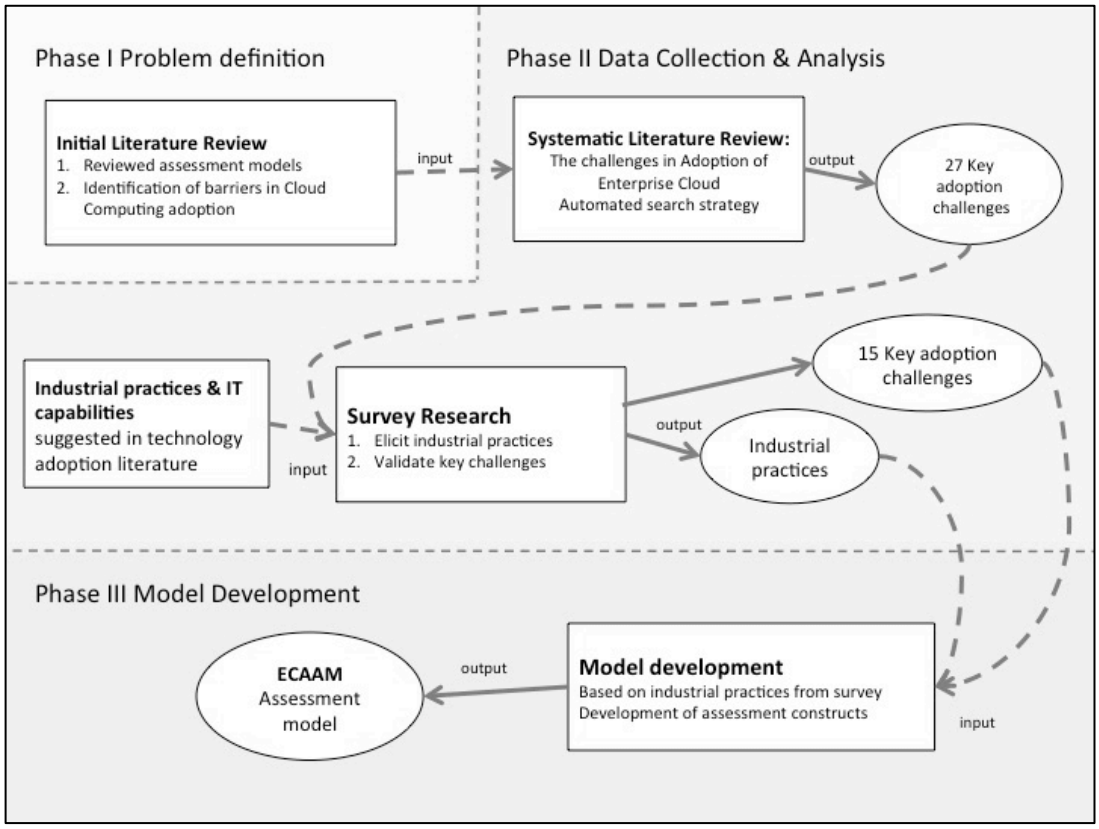

Figure 1 Study design

Problem definition phase is discussed earlier in this Section 2.1 of this chapter. In the following sections data collection, data analysis and model development are discussed.

2.2.2.1 Data Collection

The objective of the data collection phase was to collect primary data towards model development. There are two sets of data collected in this phase

1) Challenges that are barriers to adoption of Enterprise Clouds

2) Industrial Practices that help in overcoming the barriers.

One set of the primary data to be collected was *the challenges, user-concerns, and issues that impede the adoption of Enterprise Cloud Computing*. Although reviewed literature noted

several facilitating factors & barriers for adoption of Cloud Computing yet there is a need to further explore barriers in adoption of Enterprise Clouds. The reasoning behind this is as follows:

- There are similarities in technological foundations of E-business\ E-services with Cloud Computing yet the factors that influence organisational adoption differ across them. Even slight variation in technology requires its own determining factors in technical context.
- It is a general conclusion that any facilitating factor perceived low (by users) is an inhibiting factor in the adoption of that technology (Hsu, Kraemer & Dunkle, 2006; Zhu, Kraemer & Xu, 2006). Cenfetelli (2004) disagrees with this conclusion, as he believes that the perceptions of barrier to use any technology are unique and independent. This suggests studying barriers to adoption, as barriers co-exist with facilitating factors in an organisation (Cenfetelli, 2004).
- Studies on adoption of Clouds i.e. (Yanosky, 2008; Kim, 2009) and others (Xin & Levina, 2008; Heinle & Strebel, 2010; Wu, 2011a; Wu, Lan & Lee, 2011) have empirically explored factors that influence adoption ignoring the barriers.

This leads to our first research question. The first research question **RQ1** is an exploratory question by nature. Easterbrook *et al.* (2008) suggests that questions like these require an understanding of the phenomenon and the evidence; hence, there is a possibility of finding answers in the literature.

Use of the Systematic Literature Review (SLR) as the empirical method to answer the first question helped in

1) Gathering information and developing a clear understanding of the underpinning theoretical terms
2) Reviewing and critically appraising the relevant publications
3) Extraction of primary data to be used in model development.

Systematic Literature Review (SLR) or Systematic reviews helps in evaluating and interpreting all available evidence in literature relevant to a research question or phenomenon of interest (Brereton *et al.*, 2007). Systematic reviews are inherently different from ordinary literature surveys as they are methodically planned and executed. They have gained more scientific significance than ordinary literature surveys because they can be replicated independently (Kitchenham & Charters, 2007).

The decision to use SLR to seek answer for **RQ1** was taken on the following consideration:

- A better option than an ordinary literature review:

  Siwek *et al.* (2002) suggest that the systematic review is a better option than other studies as it provides a greater level of validity in findings, integrates the findings, and helps in evaluating and summarising all available evidence.

- Existing literature failed to identify adoption challenges in Enterprise Cloud Computing context:

  As discussed previously the current Cloud Computing adoption research failed to identify the challenges in the adoption of Enterprise Clouds. Secondly, most studies explored the determinants of Cloud Computing with focus on technological factors, ignoring environmental and organisational factors that are equally deterministic for the adoption of Clouds, therefore there was a need to analyse factors from all contexts including technical, organisational and environmental.

- SLR offered stronger coverage of the literature from multiple knowledge areas:

  During execution of SLR, literature is searched using well-defined search strings and terms on relevant databases, thus it offers stronger coverage of the knowledge area than ordinary literature review. The diversification of Cloud Computing research is visible as publications about Cloud technology are available in literature from Information Systems (IS), Information Technology (IT), Network

Security, Enterprise Information Systems (EIS), Enterprise IT, Enterprise IT in Education, IT Management, Software Engineering, Decision Science, Technology Management, Grid Computing and Service science knowledge domains. The adoption of Enterprise Clouds is itself a multi-disciplinary topic; associated with Management, Enterprise IT and Cloud Computing. A meticulously planned literature search ensured that all knowledge areas were thoroughly explored for the challenges in the adoption of the Enterprise Clouds.

The second primary data set was the industrial practices, technique or actions that help in overcoming the challenges in the adoption of Enterprise Cloud Computing.

The second research question **RQ2** was answered through the survey research, where early adopter of Cloud Computing technology shared their perception on the challenges in adoption of Clouds and the practices applied by them to overcome the challenges in the adoption of Enterprise Clouds. The thorough investigation of the literature and the industrial practices that helped Cloud Computing practitioner community were the empirical data collected thru application of survey research. The targeted community were IT practitioners with specific experience in deployment of Enterprise Clouds. This meant collection of information from large number of people in limited time and resources.

Survey research as a method is described as a "comprehensive system" to describe, compare or explain knowledge, attitudes and behaviour of large group of people (Barbara & Shari Lawrence, 2003). The advantage of survey is that

1) it produces real world observations or empirical data,

2) has breadth of coverage of many people and events and

3) produces a large amount of data in a short time and helps in the completion of research project within the defined timeframe (Kelley et al., 2003).

Expert interviews, focus groups and other methods were ruled out in favour of survey method.

2.2.2.2 Data Analysis

Descriptive and inferential numeric analysis is used for quantitative data whereas for thematic text or image analysis is carried out on the qualitative data (Creswell, 2009). Quantification of the qualitative data is referred as data transformation, which involves creating codes and themes qualitatively and then counting the number of times they have occurred in the text (Creswell, 2009). Creswell (2009) further observes that this process of coding transforms qualitative data into quantitative data, it does not affect its subjectivity or objectivity.

This study collected qualitative data, through a Systematic Literature review (SLR) and Survey research, which transformed quantitative data for statistical analyses. Data transformation is a popular choice and applied by several researchers in their SLRs in Software Engineering (Niazi, 2004; Staples & Niazi, 2007; Babar & Zhang, 2009; Gu & Lago, 2009; Khan, Niazi & Ahmad, 2012).

Frequency Analysis is the statistical technique used for quantitative data's analysis. Black (1999) recommends that the first step in organising qualitative or quantitative data is grouping values or scores into frequencies. Frequency tables can be used to report the number of occurrences and percentages of each data or variable. This treatment was applied to all of the challenges extracted from the SLR's results as they were grouped within themes and ranked within their own themes. The frequencies were helpful in comparing and contrasting each challenge within themes. By comparing the occurrences of one challenge against the other relative importance of each challenge was identified.

The data from SLR's results and Survey responses was analysed using frequencies and comparative analysis based on the frequencies. For example, a percentage of y for any challenge z means that the challenge z is mentioned in y% of the literature, i.e. there are difficulties in migration of current application/services to Clouds is a challenge reported in literature and has a frequency of 7 in SLR results. This means that the 28% of total 25 papers of the SLR results have reported this challenge. Further discussion on the data analysis of the SLR's results and survey's responses are discussed in Chapter 3 and Chapter 4.

2.2.2.3 Model Development

The results of the empirical research can be used for developing novel tools or techniques or even provide an insight to improve the real world software engineering practices (Dewayne, Adam & Lawrence, 2000). Answer to **RQ3** is the ECAAM assessment model, that is an organisational adoption assessment model that measures readiness to overcome the barrier to the adoption of Enterprise Cloud Computing.

ECAAM model is developed using a bottom up approach, where its assessment constructs are based on the finding of the SLR and the Survey responses. The methodology used in building model mimics the approach by Cherry & Owen (2008) where they first reviewed literature to identify factors/barrier to implementation of EHR, then used focus groups of experts to validate their finding and developed assessment constructs.

The results of SLR gave 27 key challenges, that were later reduced to 15 key challenges were validated by IT practitioner. ECAAM's assessment constructs are framed around the 15 key challenges (discussed in Chapter 4) along with practices reported by IT practitioners. ECAAM assesses organisational readiness in four organisational dimensions 1) Technical readiness 2) Legal & Compliance readiness 3) IT Capabilities readiness and 4) End users' readiness. The inspiration to segregate the items scales in dimensions is taken from previous work discussed in Sec 2.1.3

The following table presents the comparison of dimension & development methodology of existing models.

Table 6 Existing assessment models, dimension & development methodology

Existing organisational assessment models dimension and development methodology		
Framework/Model	**Dimensions/Areas**	**Development methodology**
Organizational Information Technology Innovation Readiness Scale (OITIRS) (Snyder-Halpern, 2002)	The dimensions are: Resources, End-Users, Technology, Knowledge, Processes, Values & Goals, Management Structures and Administrative Support	- Identified assessment dimensions and indicators from literature - Conducted a Delphi study to validate dimensions and indicators - Developed OITIRS - Conducted multi-site study to validate scales
Electronics Health Records - Organizational Readiness Tool (EHR-ORT) (Cherry & Owen, 2008)	The areas are: Organizational culture/human factors, Financial aspects, Implementation processes, Staff training, Evidence that systems will improve care, State regulatory support and Technical requirements	- Conducted an SLR to identify factors that facilitate or impede to EHR's implementation - Conducted focus group session with experts to identify factors that facilitate or impede EHR's implementation - Developed EHR-ORT
Texas Christian University Organizational Readiness to Change (TCU-ORC) (Lehman, Joe & Simpson, 2002)	The areas are: Motivation for change, institutional resources, personality attributes of the staff and organisational climate.	- Identified barriers to change readiness from literature - Developed TUC-ORC

ECAAM's development, its assessment constructs and industrial trial is discussed in Chapter 5. A detail comparison of the ECAAM with other models is also given in Chapter 5.

2.3 Chapter Summary

This chapter explains the background of the research, the problem domain and the proposed solution. Critical review of the relevant literature from Technology adoption, Cloud Computing and organisational assessment domains are discussed as they have helped in formulating the research questions. Several studies are presented and discussed that have reported factors that influence Cloud Computing in organisation, however their weaknesses such as lack of empirical evidence and relevance to the adoption of Cloud services required rigorous investigation of the literature. The research strategy (in Section 2.2.2) discusses research methodology applied to develop the evidence-based body of knowledge used in formulating the ECAAM model. Detailed results of SLR and Survey methodologies would be discussed in next chapters.

Chapter 3: The SLR Design and Results

Introduction

The Systematic Literature Review (SLR) was used as a data collection strategy to extract primary data from the existing literature. This chapter describes the initial search piloting, formulation of search strings, execution of search on data sources, data extraction, review of reported studies and application of thematic synthesis to analyse the extracted data reaching to findings. The challenges or issues that are barrier in the adoption of Enterprise Clouds are extracted from the literature as primary data. The findings are reported here under four themes: technical issues, organisational issues, environmental issues and security & data related concerns. The chapter concludes with a discussion of validity threats and introduces the next phase of data collection.

3.1 SLR Design & Execution

Enterprise Cloud Computing is a diverse subject, which has been broadly covered in Computing and Information Systems literature. To ensure that all relevant literature was made part of the results, SLR is the recommended methodology.

The design of this SLR is an automated search design in which key terms are applied on databases to extract publications. This SLR's design strategy is effective in giving better coverage from multiple sources. After the execution of the SLR's, the results are complied as a list of key adoption challenges in Enterprise that are reported in literature.

3.1.1 Research question

The main research question that is set to answered by the SLR method was

"What are the key challenges in the adoption of the Enterprise Cloud Computing?" (Refer to RQ1 Chapter 1 Section 1.2).

The SLR helped in identifying challenges in adoption of Enterprise Clouds. The outcome of the SLR is a synthesized list of key challenges in the adoption of Enterprise Clouds.

The systematic review was conducted in three stages i.e. planning the review, conducting the review and reporting the review based on the guidelines of Kitchenham & Charters (2007). A review protocol was developed during the planning stage with search strategy, identification of

targeted resources and conduct of a trial search. The next stages in SLR's execution are retrieval, selection, data extraction and data synthesis.

3.1.2 Search String and Trial search

Three major terms, "adoption", "challenges", "Cloud Computing", were derived from the research question by identifying the population, intervention, outcomes and study design. Synonyms, wild cards and alternative spellings were used to develop a comprehensive search string.

Table 7 Key search terms

Terms	Synonyms/Wild cards/Alternative spellings
Adoption	Implement* OR Adopt* OR Acceptance OR Appropriation OR Organisational Adoption OR Organizational Adoption OR Acquire OR Assimilation OR Deploy OR Migrate
Challenges	Barrier* OR Obstacle* OR Implementation Issue* OR Issue* OR Problem*
Enterprise Cloud Computing	Cloud Computing OR Clouds OR Cloud Technologies OR Enterprise Clouds OR Enterprise Cloud Computing OR Enterprise Cloud Service OR Enterprise Software-as-a-Service OR Enterprise Platform-as-a-Service OR Enterprise Infrastructure-as-a-Service OR Enterprise IT-as-a-Service

A trial was carried out to test the effectiveness and validity of the search terms on ACM Digital Library database. The trial string resulted in retrieval of a study (Kim *et al.*, 2009) previously identified as relevant to the research question, thus search string was deemed valid. During the trial it was observed that the term "Enterprise" resulted in irrelevant results thus, the term "Enterprise" was removed from search string.

Following is the final search string. Database specific variants were used based on these key terms:

(adopt* OR implement* organisational adoption OR assimilation OR migrat*) AND (challenge* OR barrier* OR obstacle*) AND (Cloud Computing OR Clouds OR Software-as-a-Service OR Platform-as-a-Service OR Infrastructure-as-a-Service OR IT-as-a-Service)

3.1.3 Data sources

Relevant Software Engineering, Computing and Information System databases were searched for literature in September 2011. The automated search was applied on the following literature databases and search engines:

1. IEEEXplore (http://ieeexplore.ieee.org/)
2. Science Direct (http://www.sciencedirect.com/)
3. EBSCO Host (https://www.ebscohost.com/)
4. Emerald Insight (http://www.emeraldinsight.com/)
5. Computing Research Repository (http://arxiv.org/corr/home)
6. ACM Digital Library (http://dl.acm.org/)
7. Association for Information Systems e-library (http://aisel.aisnet.org/)

IEEEXplore, ACM Digital Library, Science Direct databases are relevant to Software Engineering (Kitchenham *et al.*, 2009). Emerald Insight, Association for Information Systems e-library and Computing Research Repository are popular choices for Information Systems. The search was limited to search for papers published after year 2006.

3.1.4 Inclusion and exclusion criteria

For initial screening of studies, the following inclusion and exclusion criteria was used.

- Inclusion criteria
    - Papers describing factors, issues, or challenges in the adoption of Cloud Computing from the IT Manager's perspective.
    - Papers describing factors, issues, or challenges in the adoption of Cloud Computing from the user's perspective.
- Exclusion criteria
    - Papers not discussing issues in adoption of Clouds or
    - Papers proposing solutions to technical issues or

- Abstracts where full-text was not accessible or
- Studies/Papers focusing on inherent issues in Cloud technology.

3.1.5 Quality Assessment

The following quality assessment criteria has been adapted from Dybå & Dingsøyr (2008)'s work. Dybå & Dingsøyr (2008) discuss an eleven-point quality assessment criteria used in the systematic reviews where multiple types of studies are expected. This quality assessment criterion has been used by multiple SLRs (Major, Kyriacou & Brereton, 2012; Muhammad *et al.*, 2014) and is recommended by researchers to assess quality of extracted studies.

Applying quality assessment ensured that each study in the result set made valuable contribution towards the SLR data.

The following Quality Assessment criteria was applied:

- Does the paper have a clear statement of the aims of the research?
- Does the paper clearly defines and justifies the theoretical concepts used?
- Does the paper review the related work?
- Does the paper develop arguments based upon the theoretical concepts/frameworks?
- Does the study report the unambiguous findings, based on evidence and argument?
- Does the study has an adequate discussion and sufficient rigorous data analysis?
- Is the study of value for research or practice?
- Does study focuses on Cloud adoption issues from user or decision makers' perspectives?

The scoring scale was: Yes = 1, Partial = 0.5 and No = 0. First three criterions are generic in nature and ensured that non-research papers or paper with irrelevant frameworks are excluded. The rest of the criterions were applied to publication with case/field studies and experiments.

3.1.6 Search process

The search process was applied in **four steps**, represented in the figure below.

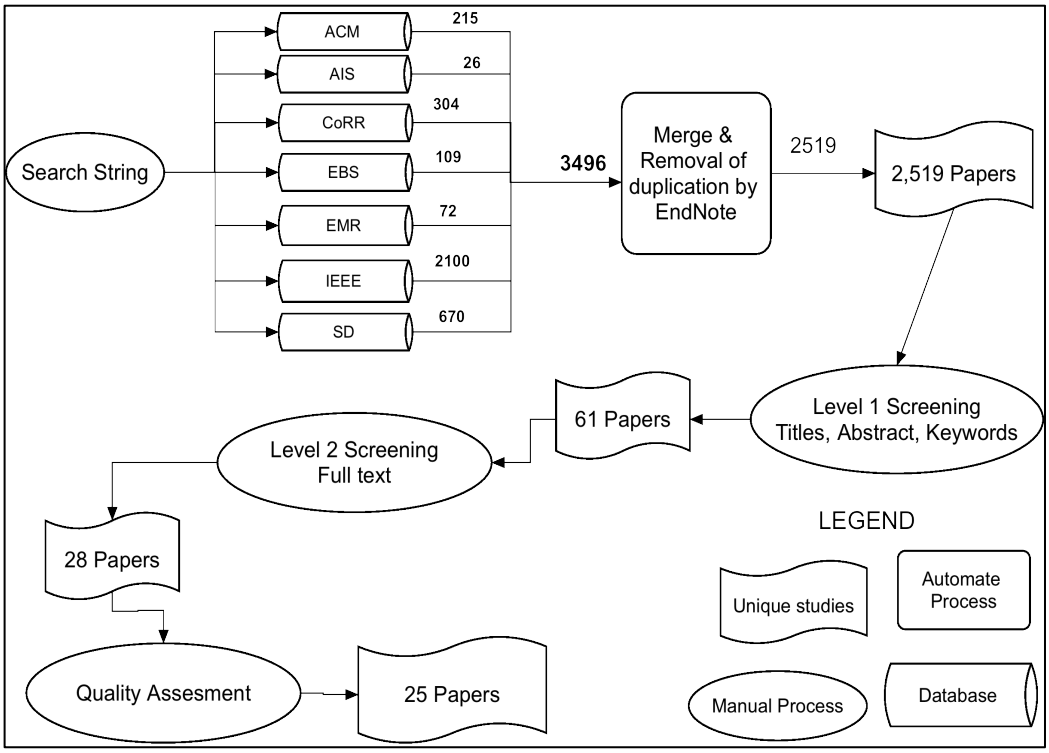

Figure 2 SLR Search process

Step 1: The key search terms were used to develop individual search strings for all the databases. The search was applied to paper titles, keywords and within abstract.

Step 2: The result from each database was extracted into publication titles & abstracts and exported to EndNote bibliography management tool in separate files. A total of 3,496 titles and abstracts were collected. EndNote software has a built in feature to remove duplications that was used to purge individual duplications within each file. All seven files were the merged into a single collective file and again duplications were removed by EndNote. This resulted into 2,519 studies. **Level 1 Screening** was review of titles, abstracts and keywords of 2,519 papers using the inclusion and exclusion criteria (described in 3.1.4). This reduced the data set to sixty-one (61) relevant studies.

Step 3: **Level 2 Screening** was reading the full text of all sixty-one (61) papers by and applying the same inclusion and exclusion criteria (described in 3.1.4). A total of 28 studies were included in SLR result. The exclusion decisions were discussed thoroughly with supervisor. To ensure consistency in application of inclusion criterion, the author and supervisor carried out inter-rater reliability test on ten randomly selected papers. Based on the agreement of both reviewers, it was concluded that as the obtained Cohen's Kappa of 0.73 is greater than the commonly applied criteria of 0.70, the inter-rater reliability is satisfactory.

Step 4: Quality assessment (discussed in Section 3.1.5) was carried out on the selected 28 studies. Supervisor reviewed the process of quality assessment to ensure consistency in the application of quality assessment. Three papers were removed from the SLR result set after application of the quality assessment criteria, leaving 25 studies in the final set.

The search results are tabulated in the given table.

Table 8 Search results and primary study selection

Database	Initial Results	Abstracts to review	Initial Paper Inclusion	Final Paper selection
ACM Digital Library (ACM)	215	160	7	2
AIS e-Library (AIS)	26	26	8	4
Computing Research Repository (CoRR)	304	304	12	5
EBSCO Host (EBS)	109	109	6	3
Emerald Research (EMR)	72	72	3	1
IEEE Xplore (IEEE)	2,100	1,582	12	4
Science Direct (SD)	670	266	13	6
Totals	3,496	2,519	61	25

3.1.7 Data Extraction and Synthesis

Thematic Synthesis Process is used for data extraction and its synthesis. Thematic Synthesis process identifies the recurring themes or issues in the primary data set, analyses themes and helps in drawing conclusions in the systematic reviews (Cruzes & Dybå, 2011b). The figure shows the steps taken in developing the SLR's output using the thematic synthesis process.

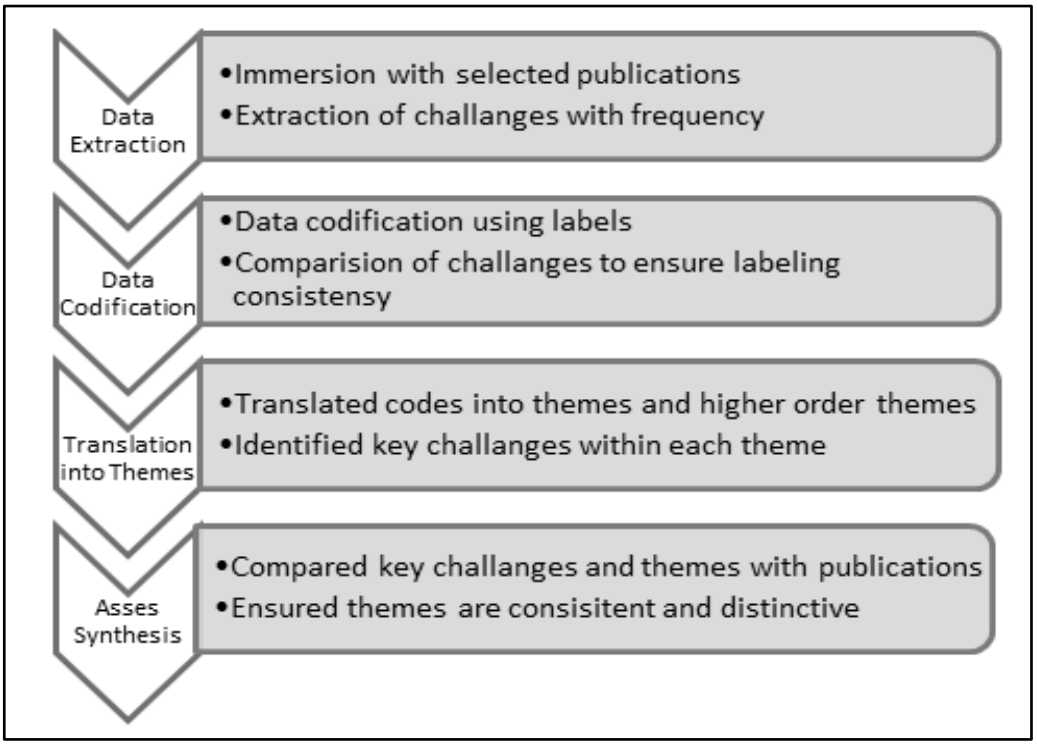

Figure 3 Thematic Synthesis Process

The first recommended step is to read "at least the entire set of selected papers once, to get immersed with the data" (Cruzes & Dybå, 2011a). Firstly, all selected papers were read (though they were earlier read for selection) with a view to identify the data that is to be extracted.

From each paper included in the SLR, following data was extracted:

- Abstract and bibliographic reference
- Type of study (Empirical, Opinion/Theoretical etc.)
- Publication type (e.g. journal paper, conference paper)
- Study aims and objectives-

- Factors/issues/barriers that are challenges in the adoption of Enterprise Cloud Computing
- Rationale behind the challenge
- Any strategy/practice to overcome challenges.

This model of data extraction (See Figure 4) was adapted from earlier systematic reviews (Staples & Niazi, 2007; Gu & Lago, 2009).

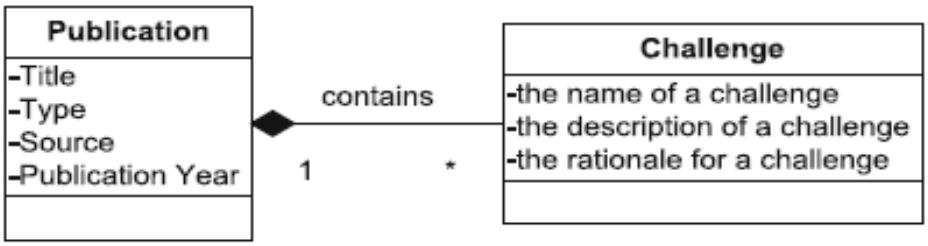

Figure 4 Data extraction model

Text in each paper was analysed with the focus on extracting adoption challenges reported in the study. Each paper had reported one or many challenges that were tabulated as a **quote** (a single quote could not be further decomposed into multiple challenges from its original description).

All quotes were tabulated in a spreadsheet noting its source and frequency of appearance in each paper. Overlapping quotes were removed or merged based on their likeness, concluding towards a final list of 80 quotes. The frequency of all 80 quotes was 226 from 25 papers (each papers was assigned an identifier Paper01 to Paper25) included in the SLR results. The following table is a small extract of the tabulation carried out of a much larger data set.

Table 9 Quote frequency tabulation (extract)

Paper / Challenge (Quote)	Paper01	Paper09	Total Freq.
Cloud Vendors Interoperability		1	1
Fear of Vendor lock-in	1	1	2
Legal issues	1		1
Non adoption to Server Virtualization	1		1
Poor internet connection	1		1
Security Concerns	1	1	2
Totals	5	3	8

Data codification phase required labelling of the entire data set. (See Annex B). Key concepts from literature were used to label and cluster 80 challenges/quotes. A start list for data label was created from concepts identified from technology adoption literature. Technology adoption literature segregates all adoption challenges into three major categories Technology, organisational and environmental issues (Refer to Chapter 2 Section 2.1.1. Table 1). The data labels that became apparent during immersion were added to the list. This is an integrated approach to develop codes (deductive and inductive) recommended as most relevant to Software Engineering (Cruzes & Dybå, 2011a).

Table 10 Labels for data codification

Data Labels			
Absorptive Capacity	Institutional Pressures	Regulatory influence	Technology integration
Availability Concerns	IT Infrastructure Issues	Reliability Concerns	Technology readiness
Compatibility	Legal & Compliance issues	Security concern	Technology resources
Competition intensity	Managerial obstacles	Service issues	Trading partners' pressure
Competitive pressure	Organisational Change	Staff issues	Trust in the service provider
Costs	Organisational readiness	Strategic Alignment	User Involvement
Data privacy concerns	Organisational size	Technological knowledge	Vendor management issues
Implementation issues	Regulatory concerns	Technology competence	Vendor selection issues

All codified data was reviewed to reduce overlapping. Weft QDA (qualitative data analysis tool) was used to compare each challenge across its source paragraph. Comparison of challenge helped in merger of the challenges based on their context and likeness of concepts.

After data labelling, the next step was to translate coding into themes. Clusters of concepts (17 unique concepts) where then classified into themes that helped in identifying and classifying the key challenges reported in literature. The themes were again checked with data and original papers to ensure consistency and distinctiveness. Sample statistics were used to identify key challenge within the themes. Two distinct higher-order themes emerged from the themes that helped in answering the research question (See Annex B for data labelling and themes). To assess the trustworthiness of synthesis process, author and supervisor cross-referenced random samples of codified data with the source text to check consistency.

3.2 SLR Results

For this SLR, a total of 2,519 titles and abstracts were reviewed, 61 papers were drawn for full review and a final set of 25 papers were accepted as result of the SLR after applying quality assessment.

Table 11 Count of studies part of SLR results

Database	Studies part of SLR results
ACM Digital Library (ACM)	2
AIS e-Library (AIS)	4
Computing Research Repository (CoRR)	5
EBSCO Host (EBS)	3
Emerald Research (EMR)	1
IEEE Xplore (IEEE)	4
Science Direct (SD)	6
Totals	25

The 25 papers (Refer to Annexure A) made part of SLR result are grouped into three types based on the applied research methodology adopted in the paper. The three types are: empirical papers (where a paper has used any empirical method) (Budgen, 2007), narrative overview (paper giving narrative overview of the literature) and research papers (where the research is based on authors' arguments or opinions evaluation of a technique etc.).

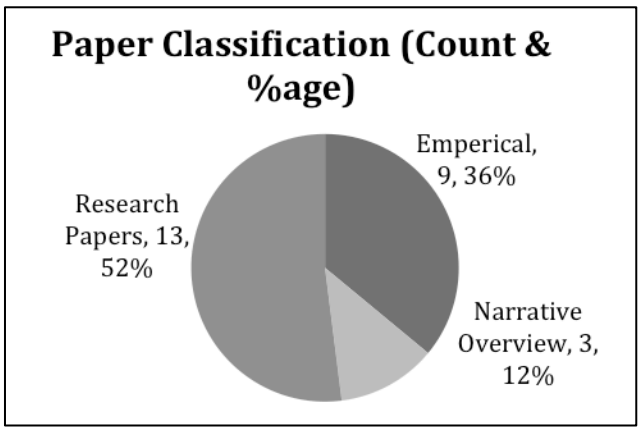

Figure 5 Paper classification count and percentage

Nine empirical papers are 36% of all papers (9 papers of 25) in SLR results, whereas 64% (16 of 25 papers) are categorised as non-empirical papers including narrative overviews, philosophical, evaluative papers etc.

The papers in SLR's results are published in Journals, conferences and other publication venues i.e. magazines, book chapters and submitted papers. The publication venue is an important aspect in quality assessment of a publication because of rigorous peer review before publication.

The Journal publications are thus considered as the most thoroughly reviewed and often the book chapters are adapted from Journal publications.

Most of the papers were published in year 2010 and 2011 whereas no relevant papers were found in 2007 and 2008, indicating that adoption issues in Clouds gained focus in recent years and increasingly captured the interest of the research community. The following table presents the details of paper types, publication venue and publication year.

Table 12 Papers' publication types and venues

Papers types and publication venues					
Paper type	Venue	Year			Grand Total
		2009	2010	2011	
Empirical	Conference		1	4	5
	Journal			3	3
	Others			1	1
	Empirical Total		***1***	***8***	***9***
Narrative Overview	Journal		1	1	2
	Others		1		1
	Narrative Overview Total		***2***	***1***	***3***
Research Papers	Conference	1	4	1	6
	Journal	1	2	2	5
	Others	1	1		2
	Research Papers Total	***3***	***7***	***3***	***13***
Grand Total		**3**	**11**	**11**	**25**

The 25 papers selected for SLR focus on Cloud Computing as their contextual framework is either a particular segment of Clouds or type of service offered by Clouds. Largest number of papers (19 of 25 i.e. 76%) discussed Cloud Computing in general context, three papers (3 of 25) focused on Software as a Service (SaaS) and its issues and adoption challenges while the remaining three papers focused on three different issues: Infrastructure as a Service (IaaS), Security and Interoperability in Clouds.

The following figure represents the values in pie chart.

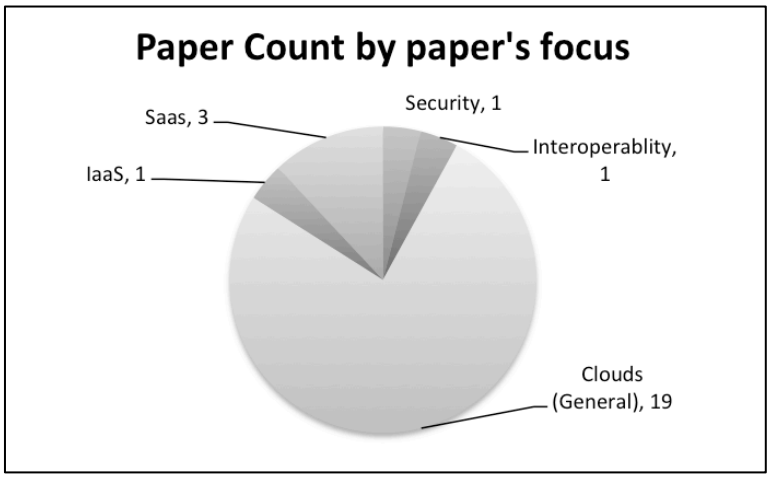

Figure 6 Paper count by paper's focus

The aim of the synthesis was to identify the challenges in the adoption of the Clouds. As mentioned earlier, all reported challenges (total 80) were tabulated and their frequency of appearance (n= 226) was noted in the selected papers.

The total challenges (80) and their frequency of 226 can be mapped to the three paper types as frequency sources. Nine empirical papers have a share of 36% of total reported challenges (81 of 226), narrative overview stands at 8% and research papers with a share of 56% emerged as the largest contributor towards the total data set of challenges. The following pie chart presents the data source and percentage contribution.

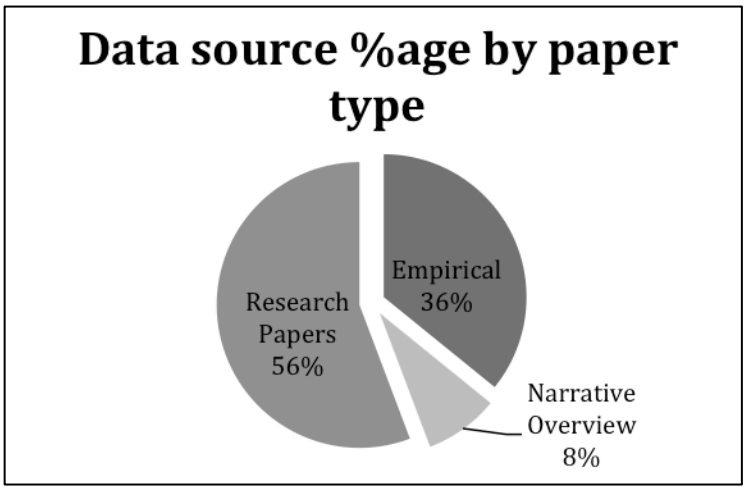

Figure 7 Data source percentage by paper type

The contribution of 36% of all reported adoption challenges are mapped to empirical studies, however this value of contribution is inadequate in making a conclusion about the strength of evidence (data set). The frequency of reported challenges (80 of 226) are taken from the paper that has an empirical study and it does not necessarily means that the extracted quote (challenge) was part of the results or conclusions of the study.

3.2.1 Higher order Themes

After the data codification of the list of 80 challenges, initially two higher order themes emerged, **Issues and Concerns** (See Annexure B).

The higher ordered theme "issues" represent the problems, barriers, challenges, difficulties and contentions that were reported in the literature.

This theme emerged from the set concepts discussed in the quotes or as the rationale behind the challenge reported in the quote. The concepts were implementation/deployment issues in Cloud Computing within an organisation, issues that were related with the IT infrastructure (including software, servers, networking, internet connection etc.), issues relating to the service offered by IT department or IT services in general, issues that emerge because of End users or IT Staff (including resistance from end users, IT Staff turnover etc.), vendor selection and management, legal obstacles in implementation of Clouds or Non-Compliance with existing laws or rules and lastly the issues that arise due to organisational change associated with technology. **The issues were further grouped into three themes, Technical issues, Organisational issues and Environmental issues**.

Below is the figure that represents the concept mapping of issues in sub-thematic grouping.

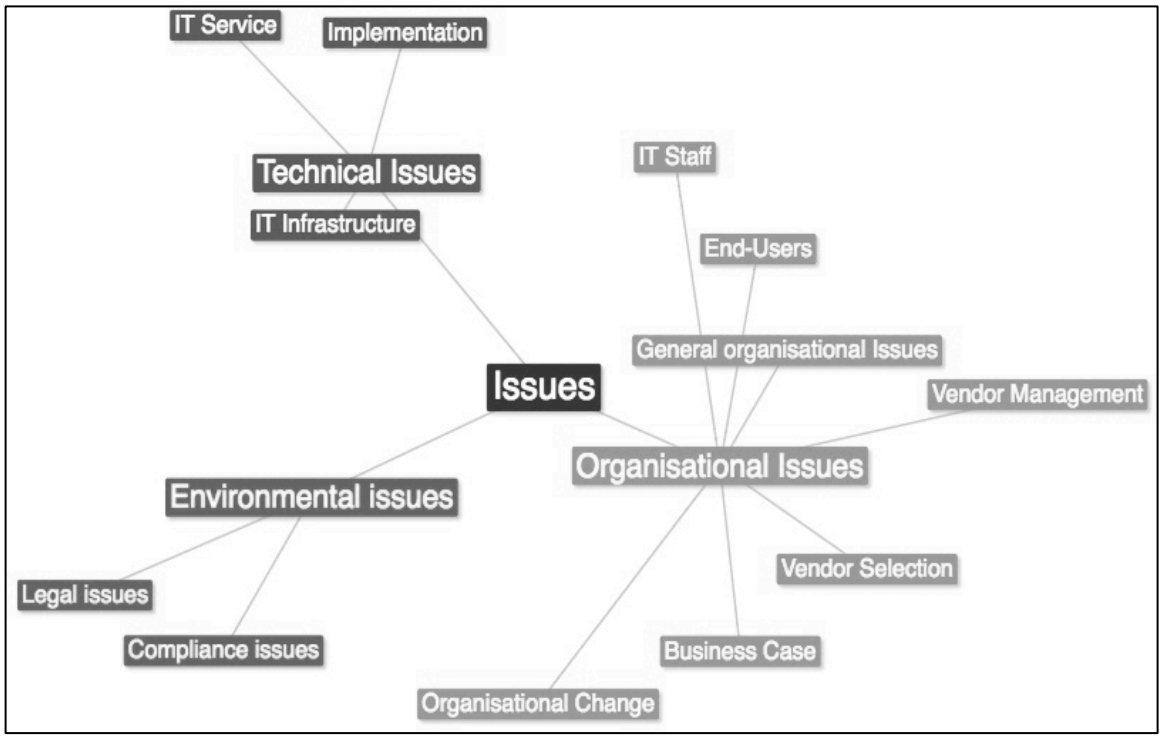

Figure 8 Issues and their thematic division

The "concerns" emerged as the second higher ordered theme from the labelled quotes. The concepts associated with end users, IT staff, IT Manager or any stakeholders concerned with the Cloud services were grouped under this higher-order theme. The concepts that are applied during data codification were Cloud services availability, data privacy concerns, other data related concerns (i.e. data loss, data leakage, data migration, data placement etc.), Clouds service reliability, security concerns from clients' side and security concerns that emerge from vendor's side. **The other two themes that emerged from concerns were data and services related concerns, and security related concerns in the adoption of Cloud Computing.**

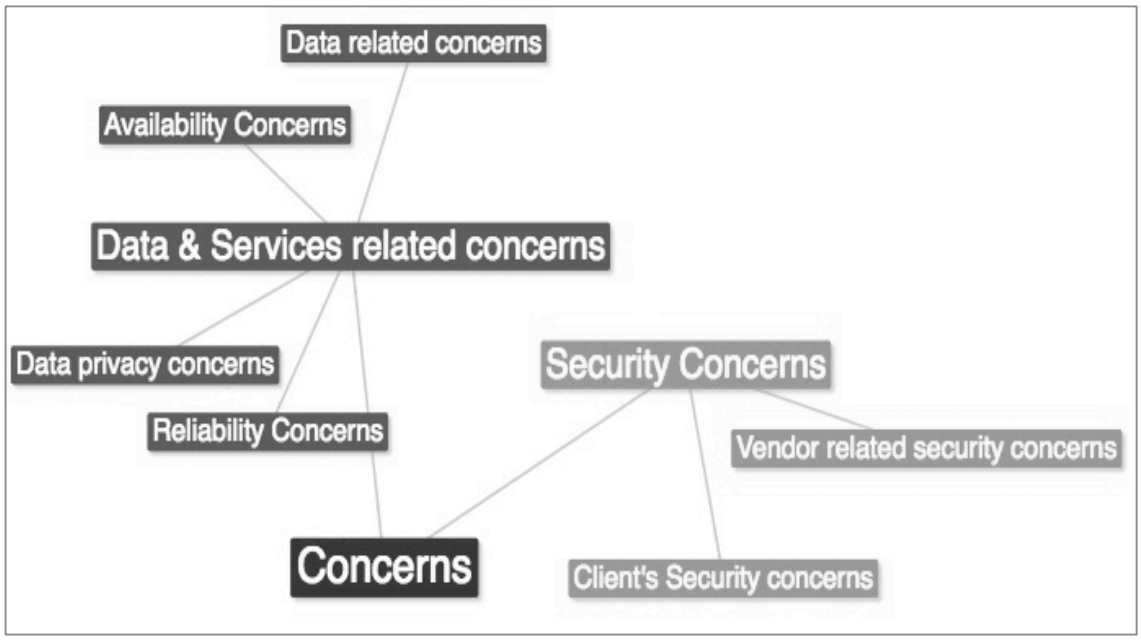

Figure 9 Concerns and their thematic division

Frequencies, means and standard deviation values of all the themes are presented in the following table.

Table 13 Themes: Frequency, Means and standard deviation

Themes	Challenges in Cloud Adoption			
	Frequency	Percentage Frequency	Within Theme	
			Mean	s.d
Technical Issues	58	26%	3.02	2.38
Organisational Issues	74	33%	2.05	1.21
Environmental Issues	13	6%	6.5	6.36
Data & Services related concerns	48	21%	4.36	3.93
Security Concerns	33	15%	2.54	3.84
	226			

The highest number of challenges are grouped as organisational issues with a frequency of 74 that is 33% of total quotes, followed by security concerns, which are 21% of the quotes, technical issues 26%, 15% data and service related concerns and 6% are environmental issues in the adoption of Clouds.

3.2.1 Challenges in the adoption of Clouds

Kim *et al.* (2009) [Paper01] discussed adoption of Clouds in the context of large-scale organisations. They have focused on Comparing Clouds adoption issues of small and medium scale organisations with Enterprise, arguing that issues of small-scale organisation are different from Enterprises. They reported several issues such as outage, security, performance, compliance, decision to adoption public or private Cloud, integration and cost as challenges. They considered cost as an issue in adoption as they believe that hidden cost and use of dedicated physical resources to counter security concerns would erode the cost advantage offered by the Clouds (Kim *et al.*, 2009). Kim *et al.* (2009) have also pointed out that most of the Enterprises initially deploy private Clouds as test-bed and then move on to Public Clouds, thus creating data migration issues between private – public Clouds and perhaps an issue with adoption of Clouds itself (Kim *et al.*, 2009).

Armbrust *et al.* (2010) [Paper02] is the first paper in the series of papers from Cloud Computing research group funded by IBM and Google. This paper declares Cloud as an emerging technology and offers an insight to the opportunities it offers and obstacles in its adoption. The obstacles that impede Clouds' adoption are service availability, data lock-in and data confidentiality and lack of auditability of vendor. Data lock-in and its impact on interoperability is mentioned as a major hurdle in adoption, whereas they have argued about the presence of concerns on data security and privacy. Some of the issues reported by them are inherent to the use of off-premises and outsource services but they feel that lack of APIs for migration and absence of liability for failure does have negative affect on adoption. Other notable challenges pointed out by them are concerns related to reputation loss, lack of compliance, loss of control over resources, performance of Cloud and uncertainty with Cloud technology (Armbrust *et al.*, 2010). However, Armbrust *et al.* (2010) are of the view that the issues themselves offer possibilities of new services developed around them.

Nuseibeh (2011) [Paper04] used three theories, Transaction Cost Theory, Resource Dependency Theory and Diffusion of Innovation Theory, to develop a theoretical model to measure propensity to adopt Cloud Computing. His work discusses several concerns and issues that are barrier to adoption of Clouds. He has summarised adoption challenges as technical, concerns or

risks, security issues, legal, organisational and financial concerns from Vendor side. Challenges such as issues of Cloud failure, vendor's vulnerability to attacks, data leakage, fear of vendor lock-in, lack of expertise in drafting SLAs, presence of malicious insiders at the Cloud vendor, performance of Cloud Service and security concerns are also reported in this paper (Nuseibeh, 2011).

Simalango, Kang & Oh (2010) [Paper07] have proposed a process of Cloud adoption in organisations. They defined a strategic process that helps migration of legacy systems on Clouds focusing on the adopters with extensive application performance requirements. This work outlines two approaches towards adoption of Clouds, top-down and hybrid. In Top down approach the Cloud adoption is initiated from top management as a part of the organisational strategy and IT department implement it whereas hybrid approach starts as an internal process of the IT department seeking new technology (Simalango, Kang & Oh, 2010).

The hybrid approach described by Simalango, Kang & Oh (2010) involves initiation and user testing on small scale and then top management is approached for adoption for the entire organisation. In their opinion, hybrid approach can lead to successful adoption in comparison to top-down approach as the former involves user testing and has more iteration than the latter. The strategic framework consists of four stages, assessment, differentiation, design and evaluation with each stage having customizable sub-processes. They have discussed that adopter have security related concerns, concerns on data privacy, issues with lack of compliance and lack trust in Cloud vendor. Simalango, Kang & Oh (2010) feel that adoption of Cloud impacts legacy systems and brings changes within an organisation, thus offering poor economic incentives in lieu of the organisational change.

Bisong & Rahman (2011) [Paper08] discuss security threats, risk and challenges in context of Enterprise Cloud Computing. Their work discusses security threats to an Enterprise and the reported challenges are fear of vendor lock-in, service or traffic hijacking, client's staff's misuse of Cloud Computing services, insecure Cloud access and lack of trust on Cloud vendor. This work greatly cites commercial reports, IT blogs and white papers to support its argument and authors' opinion.

Paquette, Jaeger & Wilson (2010) [Paper22] focuses on security issues in the implementation of Cloud Computing in public sector. US Federal government takes Cloud Computing as an enabler in Federal IT transformation strategy and uses public cloud environment for information sharing (Paquette, Jaeger & Wilson, 2010). The risks associated with implementing Clouds at public sector organisations include policy changes and changes in existing IT infrastructure. They have highlighted several issues as hurdles to the adoption of Clouds: access issues, security concerns, availability of service provider, issue of compliance (specific to public sector policies and laws), data integrity and data security. Besides changes in public sector acquisitions, contract management processes, lack of public policy on data ownership, responsibility and liability generates unnecessary hurdles in implementing Clouds (Paquette, Jaeger & Wilson, 2010).

Marston *et al.* (2010) [Paper21] discuss implementation of Cloud Computing from business perspective. They used SWOT analysis to look at Cloud's weaknesses in technology, opportunities and strengths. They have highlighted challenges in adopting Clouds as vendor's availability, concerns about data loss, concerns about loss of control over resources and security apprehensions.

Subashini & Kavitha (2010) [Paper23], conducted as a review of security issues in all three Cloud services (SaaS, PaaS and IaaS), are of the opinion that security issues related to three Cloud services are unique and cannot be taken as one, thus they require to be studied individually. They identified several security and adoption related issues i.e. user's security concerns, client's concern about exposure to malicious resources on Public Clouds, lack of security and issues with legal compliance (Subashini & Kavitha, 2010).

3.2.3 Review: Empirical Studies

Nine papers have used empirical methods to report experience or perceptions related to issues in the adoption of Clouds. The empirical studies in the SLR results have used three methods for data collection: case studies, interviews and questionnaire based surveys. Industrial settings of the empirical studies are Universities, Oil and Gas exploration, and Public sector organisations. The focus of the empirical studies has been on Cloud Computing as a whole, Software as a Service (SaaS) and Infrastructure as a Service (IaaS). The following table shows the count of papers according to empirical method, their context and focus.

Table 14 Empirical Papers, Focus and contexts

Empirical Methods	Focus	Study's Context or Industrial Setting				
		Education	Oil & Gas	Public sector	Enterprise*	Total
Case Study	Clouds	3				4
	IaaS		1			
Interviews	Clouds				2	3
	SaaS			1		
Survey	Clouds				1	2
	SaaS		1			
	Total	3	2	1	3	9

* *Multiple industries*

Four empirical studies, Sarkar & Young (2011) [Paper05], Greenwood *et al.* (2010) [Paper09] , Sultan (2010) [Paper24] and Khajeh-Hosseini *et al.* (2011) [Paper19] are single case study designs where unit of analysis is one single organisation (first three case studies are set in Universities). Single case design studies have two inherent weaknesses: first is the question about the generalizability of results from a single case and second is author's biased views to influence the direction of the findings or conclusions (Yin, 2002). However, weakness of being a single-case design of the case-studies reported in the 4 empirical papers in the SLR result set makes them fair evidence (acceptable in data) towards the SLR results as no background information is provided as the reason for using the single case.

Sarkar & Young (2011) report a case study that aims to investigate an Australian University's motivation and decision in migrating some of its existing IT services to Clouds. The resulting data was reported as motivation factors and concerns thus concluding all non-motivating factors as barrier to adoption of Clouds. The most significant issues were fear of vendor lock-in,

end-users' security concerns, user's concerns about data privacy, change in IT department's role and migration issues with the existing legacy application and systems.

Sultan (2010) is a single case-study design that explores the issues faced by IT staff at an Educational institution implementing Cloud Services. The motivation behind the implementation of Clouds was to reduce cost and improve quality of service. The study focuses on the concerns and issues creating hurdles in adoption of Clouds and mentions vendor lock-in, trust on Clouds, loss of control over resources, post implementation performance, security, privacy, reliability and legal issues.

Greenwood *et al.* (2010) have developed a decision support toolkit (Cloud Adoption Toolkit) that helps the stakeholders in identifying risks and benefits of Cloud adoption. This study uses the toolkit in supporting a University's decision to migrate some IT services to Clouds. The reported outcomes of this single case design are several stakeholders' concerns perceived as adoption risk. The concerns are change in dynamics of IT department, lack of organisational readiness, complicated billing, legal issues and difficulties in migration of current applications. Greenwood *et al.* (2010) reports on the experience of using the Cloud Adoption Toolkit that helps in making migration decision for Enterprise IT Systems with an aim to migrate to Infrastructure as a Service (IaaS). The paper reports that the hurdles in adoption of Clouds were deterioration in Customer care and Service quality and an increased dependence on third party vendor. Decrease in satisfactory work and increased workload of IT staff were identified as post-implementation risks (Greenwood *et al.*, 2010). Both these studies focused on Cloud adoption decision and the stakeholder's concerns and lessons learned were indirect outcomes of these case studies.

Three studies (Benlian & Hess, 2011) [Paper20], (Janssen & Joha, 2011)[Paper06], and (Luoma & Nyberg, 2011)[Paper03] have used interviews with IT executives to collect primary data for their work. All three studies were aimed at exploring adoption issues and have used perceptions and experience of IT Managers to present risk or challenges in adoption of Clouds or its services.

Benlian & Hess (2011) [Paper20] focused on risk and opportunities in adoption of Software as a Service (SaaS) and developed an opportunity-risk framework. They interviewed IT executives from adopters and non-adopter organisations, developed the factors for framework and compared

the results. Data privacy, security concerns, loss of internal expertise (IT Capabilities) are the challenges or risks faced by the adopters, whereas non-adaptor's perception of vendor's availability and hidden cost are the challenges in their adoption. Identifying risk in technology adoption using adopter and non-adopter's view is a novel technique that helps in brining both perspectives to light (Benlian & Hess, 2011). The study design is very robust in nature and data has been analysed by using several techniques to ensure removal of biases, however, the focus of study are a specific set of risk and opportunities based on literature constructing the IT executives' views. Besides the close nature of risk factors, the study does not make distinction between IT Managers that are starting from scratch and others that are replacing/upgrading existing services (Benlian & Hess, 2011). This particular work is considered as good evidence.

Janssen & Joha (2011) [Paper06] reports an empirical study on the adoption of Software as a Service (SaaS) in Danish public sector organisations. They conducted interviews with IT Managers, outsourcing specialists, decision makers and IT experts from several public sector organisations and classified the SaaS adoption challenges into five major areas: organisation, performance, decision, contract and relationship. Interviewees equated SaaS adoption decision with outsourcing decision which has an inter-organisation impact and the issues that are barrier in the adoption of SaaS are concerns about quality of service, vendor's business continuity, change in work culture, need for strategic alignment and potential vendor lock-in (Janssen & Joha, 2011). The study's conclusions are based on rigorous background review, arguments supported by outsourcing literature and focuses on the challenges in adoption of SaaS, thus considered as good evidence.

Luoma & Nyberg (2011) [Paper03] examined four adoption scenarios of adoption of Cloud Computing in China. To develop scenarios, interviews with Chinese IT Executives were conducted to elicit current trends of the IT industry and adoption of Clouds in China. The initial findings were grouped as political, social, economical and technological trends. Another round of interviews were conducted with Chinese academicians to verify the findings, discussing the scenarios and drawing up the conclusions. The reasons reported behind the slower adoption of the Clouds in China are: security concerns, lack of regulations, lack of capabilities, no laws for Clouds and lack of implementation of server virtualization technology (Luoma & Nyberg, 2011). In this work, the IT

executives did not directly report the challenges or issues in Cloud adoption rather these issues are the conclusion of the authors (Luoma & Nyberg, 2011). The response of the second group is akin to face validity of the extracted data thus it is a weakness of this study, making it a part of fair evidence (acceptable in data).

Chinyao, Yahsueh & Mingchang (2011) [Paper15] carried out a study on factors that influence Cloud Computing adoption in Taiwanese industry and use of TOE factors. This study concludes that results are consistent with earlier studies of technology adoption as it observed that technical, organisational and environmental factors influence diffusion of Cloud computing services. Authors have reported complexity, non-compatibility with existing technology, lack of top management support, scale of firm size and lack of technology readiness as barriers in Cloud adoption (Chinyao, Yahsueh & Mingchang, 2011). This work is not directly aimed at collecting perception or experience rather the focus was on finding the facilitating adoption factors, lack of which can be taken as barrier to adoption. Based on this weakness, this work is taken as part of fair evidence.

Wu (2011b) [Paper25] used Technology Acceptance Model and Rough Set Theory to explore the significant factors affecting the adoption of SaaS in an Enterprise. The primary data comes from survey of users at IT/MIS companies in Taiwan. The study concludes that security apprehensions and lack of trust on Cloud vendor are significant factors that affect adoption decisions. The focus of study is to find the factors affecting adoption thus these factors are barriers to adoption of SaaS (Wu, 2011b). This work is taken as part of good evidence because it directly explores user concerns on adoption of Software as a Service in Clouds.

3.3 Key Challenges in adoption of Enterprise Clouds

Frequency Analysis of the challenges was carried to rank the challenges reported in the literature. Based on frequency, the highest concern was the general security concerns or apprehensions about Cloud Computing, followed by reliability concerns about Cloud Computing services and Legal/Compliance issues in using or adopting Cloud Computing as second and third highest respectively. The following table represents the top ten Cloud adoption challenges ranked by their frequency of appearance in 25 papers.

Table 15 Top ten adoption challenges ranked by frequency

Top Ten Cloud Adoption Challenges (ranked by frequency)			
Theme	**Challenges**	**Frequency**	**Ranking by Frequency***
Security Concerns	Security concerns/apprehension about Cloud Computing	15	1
Data & Services related concerns	Reliability of services offered by Cloud Vendor	13	2
Environmental issues	Legal or Compliance issues in migrating to or accessing Cloud Computing	11	3
Technical Issues	Vendor /Service lock-in issues	9	4.5
Data & Services related concerns	Privacy of data stored on Cloud	9	4.5
Technical Issues	Difficulties in Application/Service migration to Cloud Computing	7	7
Technical Issues	Lack of interoperability between Cloud service or Cloud Vendors	7	7
Data & Services related concerns	Availability of service/Cloud vendor	7	7
Organisational Issues	Change in IT Dept.'s role/authority	5	9.5
Organisational Issues	Increased dependence on a third party provider	5	9.5

** Average rank are assigned to tied values*

These top ten adoption challenges ranked by their frequency are not representative of the all the themes that emerged in the data set. A small number of organisational issues are part of the top ten adoption challenges. The use of top ten ranking ignored other significant challenges reported in the literature grouped under themes and also limits the data set to a small number of challenges. Khan, Niazi & Ahmad (2012) identified critical success factors by selecting the ones reported in more than 50% of papers of their SLR result set, however by applying this on the data-set only two challenges would be selected limiting the data set again.

Therefore, it was decided to seek other criterion to identify the significance of adoption challenges among all the challenges. After discussions with fellow researchers in University's Software Engineering research group, it was suggested to ensure that key challenges should represent all themes. The heuristic criteria that I used to identify the key challenges from codified data set was

"A challenge with frequency value higher than the mean of its theme is a key challenge within that theme".

By applying this criteria, 27 challenges were identified as key challenges with each of them having significance within its theme. The 27 key challenges are from five themes and the following table presents the counts and percentage share .

Table 16 Themes and Key challenges in adoption of Clouds

Themes & Key challenges in adoption of Clouds		
Themes	Count	%age from Theme
Technical Issues	10	37%
Organisational Issues	10	37%
Environmental issues	1	4%
Data & Services related concerns	4	15%
Security Concerns	2	7%
Total key challenges	27	

Following sections present key challenges within each themes.

3.3.1 Technical Issues

The first theme of the challenges in the adoption of Clouds is the technical issues that are barrier to the adoption. Technical challenges reported in literature are discussed in context of implementation, existing IT infrastructure and IT services. The key challenges reported in literature as technical issues are:

Table 17 Technical Issues

Technical Issues		
Key Challenges	**Frequency**	**Reported in % of papers**
Vendor /Service lock-in issues	9	36%
Difficulties in Application/Service migration to Cloud Computing	7	28%
Lack of interoperability between Cloud service or Cloud Vendors	7	28%
Incompatibility of existing IT Infrastructure/Resources for Cloud Computing	4	16%
Increase in IT Dept.'s operational cost	4	16%
Loss of control over IT resources after migration on Clouds	4	16%
Decrease in service performance after migrating services on Cloud Computing	4	16%
Excessive effort is required to re-engineer legacy applications for migration on Clouds	3	12%
Lack of sufficient migration support from Cloud Vendor	3	12%
Lack of QoS or SLA monitoring solutions	3	12%

Total number of papers in SLR n=25

Cloud Vendor/Service lock-in issue is reported in 36% of the SLR's results. The context in which this issue is discussed in papers is that Cloud vendor's services would have a lock-in effect on the client's data and services, creating a technological lock-in effect barring switching to other technology in future. This issue weakens the business case significantly as adoption of Public Cloud service is not simple vendor lock-in, it leads to data lock-in, lock-in to particular development environment and development languages etc. (Luoma & Nyberg, 2011). Customer lock-in gives Cloud vendor an advantage over pricing as they can make customer pay a higher service cost later (Luoma & Nyberg, 2011). The lock-in effect makes data or service migration to other Clouds costly thus it is considered as a barrier in the adoption of Cloud technology (Armbrust *et al.*, 2010)

Lack of interoperability between Cloud service/vendors is reported in 28% of the SLR's results. The lack of interoperability of Cloud services to access or use other Cloud services is a challenge in adoption of Clouds (Kim, 2009; Kim *et al.*, 2009)

Interoperability is not limited to using two different Cloud vendors (Google and Salseforce.com) as it can be a link between the Clouds and organisations' existing IT Systems. Seamless integration of on-premises IT Systems with Clouds is difficult due to proprietary APIs and complex data structures creating incompatibility issues (Dillon, Chen & Chang, 2010). The interoperability of Cloud brings innovation of services and reduction of cost in accessing multiple services from multiple vendors (Neal, 2009).

The challenge for the IT Managers is that they do not have the technology or available support that can facilitate them to interoperate Clouds or Cloud services (Khajeh-Hosseini, Greenwood & Sommerville, 2010). Interoperability of Cloud services was initially not a priority in the Cloud industry but now several industrial initiatives are working towards achieving interoperability (IBM, 2010)

Current application/services are difficult to migrate on Clouds: 28% of the papers report that current applications/services in the organisation are difficult to migrate on Clouds. Existing application or services are known to create difficulties while migrating to Clouds (Khalidi, 2011). These difficulties such as effort, cost, lack of resources, architectural incompatibility and in some cases the migration cost simply outweighs the benefits (in case of ERPs) discourage the IT Leadership in using Clouds (Chinyao, Yahsueh & Mingchang, 2011). Besides Enterprises have legacy systems that pose another challenge as it would be a bigger project to re-engineer (Re-design of software architecture, rewriting of legacy code) legacy systems for Clouds than implementing Clouds.

The migrating of existing services need deployment support from vendor's side, which is not available at times and reportedly dissuades Enterprises to adopt Clouds (Farrell, 2009; Qamar, Lal & Singh, 2010). Due to the newness of Cloud technology and the lack of internal expertise, Enterprises look up to the Cloud vendors for support in migration activities/project (Khajeh-Hosseini

et al., 2011). Few large Cloud vendors do offer implementation support through their retail-partners or solutions-partners (Dillon, Chen & Chang, 2010).

Clouds' implementation becomes technically challenged in IT environment where certain IT infrastructure resources are not available. The most prominent of the technologies for Cloud adoption is high-speed internet connectivity and virtualisation technology that makes adoption difficult (Luoma & Nyberg, 2011). Organisations that are not using server virtualisation technology (being the foundation of Cloud technology) are slow to adopt Clouds (Luoma & Nyberg, 2011). At times considerable investment is required for upgrading the existing IT infrastructure to use Clouds. Khajeh-Hosseini *et al.* (2010) reports about the client's apprehension to invest in upgrading the IT infrastructure for using Clouds. The client (an Oil and Gas exploration company) had several offices in remote locations where provision for high speed and reliable Internet connectivity was a challenge itself. Making capital investment in upgrading the current infrastructure for Clouds weakens the stance of migrating to Clouds, as one of the considerations for migration to Clouds is reduction in capital expenditure (Nuseibeh, 2011).

Several technical challenges are associated with impact of Clouds on the IT services offered within organisations. Several studies (Kim *et al.*, 2009; Dawoud, Takouna & Meinel, 2010; Dillon, Chen & Chang, 2010; Paquette, Jaeger & Wilson, 2010) reported that migration of service and data on Clouds increases operational cost of IT. The increase in IT's operational cost could be due to increased bandwidth consumption, need to maintain on-premises backup and stand-by arrangement with other/secondary Cloud Vendor (Kim, 2009). Poor data latency, network throughput and monitoring of vendor services would also result in increased operational cost (Kim, 2009; Simalango, Kang & Oh, 2010).

Poor performance of system after migration on Clouds is another major hurdle in the adoption of Clouds and is discussed in 16% of SLR's papers. Customers with long geographical distance from Cloud vendors' servers face poor latency once data traffic increases (Neal, 2009). Increase in number of users who logged in simultaneously also deteriorates performance and increases transaction turnaround time (Kim et al., 2009).

IT Administrators need to have control and visibility of the IT infrastructures that they are managing. The control is the ability to decide about data access privileges, data deletion decisions and confidence that possible actions are not subverted, whereas visibility is ability to know how data and programs are accessed (Badger *et al.*, 2012). The migration of IT services on Clouds transfers the control over to vendor as this makes a challenge for IT Managers to retain control, as *is highlighted in 16% of the papers*. The control and visibility which IT Managers exercise over on-premises IT resources is missing Public Clouds offering (services or IT resources) and thus they effectively lose control (Neal, 2009).

Any organisations would require monitoring of service performance and availability of the Cloud services. There are various tools for monitoring network service quality (QoS) variables, and they are regularly used for monitoring network services. Most of the QoS tools are designed for LAN/WAN monitoring and are unfit for Clouds services due to different performance variables or not having variables matching multiple SLA agreements (Nuseibeh, 2011). Lack of QoS monitoring tools makes SLA supervision difficult and cause client-vendor relationship breakdowns (Janssen & Joha, 2011). Besides mismatch of the QoS tools, SLA monitoring is complicated due to vague service parameters. These technical issues essentially deter IT Managers to foray migration to Clouds as it technically becomes an un-manageable territory for them.

3.3.2 Organisational Issues

The organisational issues are the challenges that are issues, factors or barriers reported in context of the organisation. The issues highlighted in the SLR's results are segregated by two distinct views: the organisation and the IT department as a unit. From the organisation's perspective the reported challenges relate to the issues in organisation, its process and issues faced by its people (particularly the end-users) regarding the Enterprise Clouds. Whereas, the second perspective is related to issues of IT department's work. The issues that are barrier to adoption of Enterprise Clouds are related to vendor management and selection, business case development, change in work pattern, change in role and issues with IT staff (staffing issues, turnover, lack of skills etc.). The key challenges reported in literature as organisational issues are listed in the table below (See Table 18):

Table 18 Organisational Issues

Organisational Issues		
Key Challenges	**Frequency**	**Reported in % of papers**
Lack of Organisational readiness	3	12%
End-user resistance to change	3	12%
Change in IT Dept.'s role/authority	5	20%
Changed IT organisational work patterns	3	12%
IT Staff's resistance to change	3	12%
Loss of internal expertise (IT Capabilities)	3	12%
Increased dependence on a third party provider	5	20%
No indemnity for service failure by Cloud Vendor	4	16%
Difficulty in determining Cloud Vendor's long-term viability or sustainability	5	20%
Lack of client's right to audit Cloud Vendors' services or security protocols	3	12%

Total number of papers in SLR n=25

Organisational readiness in context of technology adoption is organisational capabilities and their state of preparedness for using that particular technology (Chen, 1996). Readiness includes employees' capabilities, business process changes and organisational resources committed towards the technological change (Lehman, Joe & Simpson, 2002). Organisational preparedness requires planning and effort to bring an alignment in the chosen technology (Lehman, Joe & Simpson, 2002). Several issues such as poor support of top management, weak implementation planning, immature IT processes and even some organisational characteristics, makes an

organisation misaligned for the Cloud technology (Khajeh-Hosseini *et al.*, 2010; Chinyao, Yahsueh & Mingchang, 2011). Khajeh-Hosseini *et al.* (2011) identifies poor organisational readiness as an implementation risk that can cause failure of the Cloud migration project.

End user's resistance to change has been reported as a key challenge in adoption of Clouds (Antonopoulos *et al.*, 2010; Khajeh-Hosseini, Sommerville & Sriram, 2010; Khajeh-Hosseini *et al.*, 2012). End user's lack of understating of Cloud technology also generates negative feeling towards technology (Marston *et al.*, 2010).

The issues related to the IT staff issues were discussed in several contexts in literature such as possibility of staff turnover, lack of skills, need for new training, changes in work and their problems in vendor management and selection of the vendor. The key challenges reported in literature related to the IT staff are:

- Change in IT Dept.'s role/authority: Khajeh-Hosseini *et al.* (2012) notes that that Cloud adoption would change IT department's role from service providers to "just certifier" of available services. This shift is based on the change in working of IT department as Cloud services could be used (or procured to be precise) directly by End-users, changing the IT department's role in the transactions. The new IT role would be to certify fitness of purpose, monitor and foot the bill on end-user' behalf (Khajeh-Hosseini, Greenwood & Sommerville, 2010).

- Changed IT organisational work patterns: Greenwood *et al.* (2010) reported that IT staff has issues with changes in their work and have expressed concerns about changes in IT procurement process, auditing and compliance processes after adoption of Clouds. These changes could also have a negative impact on organisational culture and working patterns (Ming-Ju & Woan-Yuh, 2008; Chinyao, Yahsueh & Mingchang, 2011; Janssen & Joha, 2011).

- IT Staff's resistance to change and loss of internal expertise are reported as challenges in adopting Clouds. Khajeh-Hosseini *et al.* (2012) report that redundancy threats, change in work patterns, decrease in IT work and pressure to learn new skills, force the IT staff to resist Cloud implementations. Besides resistance to change, redundancy is a generally prevalent perception related to Clouds (Subashini & Kavitha, 2010). Reduction in staff's strength and possibility of

turnover after implementation of Clouds would lead to loss of internal expertise within IT departments (Benlian, Hess & Buxmann, 2009; Benlian & Hess, 2011; Chinyao, Yahsueh & Mingchang, 2011). Sarkar & Young (2011) report that the loss of internal capabilities is a challenge, as it prevents the organisation to "back-source the migrated services". Besides loss of expertise, lack of technical expertise to implement and integrate Cloud technology in current IT staff is also an issue. Cloud Computing deployment projects require different skills set than what is usually available in the current IT staffing, thus staff training would be inevitable during and after Cloud Computing implementation (Janssen & Joha, 2011). However, many organisations feel that training staff for Clouds would be risky as they could switch jobs due to high demand for IT staff with Cloud implementation experience (Janssen & Joha, 2011).

Generally outsourcing IT services makes the organisation dependent on third party provider, though this issue is inherent when outsourcing any organisational service (Call center, Logistics etc.) to any third party. Migration of all IT services on a single Cloud makes IT department "too much dependent" on a single service provider and is consider a barrier in using Clouds (Qamar, Lal & Singh, 2010; Janssen & Joha, 2011; Sarkar & Young, 2011).

Not only managing Clouds poses challenges for IT staff, selecting the appropriate vendor is an issue too. Choosing the right Cloud vendor is a critical decision for IT Executives. There are several issues in vendor selection i.e. lack of SLA analysis frameworks and incomparable pricing mechanisms but most significant are vendor's long-term viability, audit of the vendor services and no liability is offered by the vendor in case of failure.

- There are a large number of Cloud vendors offering their services. Due to competitive nature of IT business, vendor could go out of business any time. Long-term sustainability of a service provider is a key factor in adoption of Clouds (Greenwood *et al.*, 2010). If the vendor goes out of business during the period of SLA it could lead to data loss, issues with exporting data back or even to another Cloud vendor, issues of data privacy and eventual question of data ownership (Farrell, 2009). IT Executives tend to choose established Cloud vendor over a newer vendor considering experience in business as long-term viability of the service provider (Kim *et al.*, 2009).

- Gupta (2010) reports that vendor's compliance with required laws is a critical factor in selection of the Cloud vendor. One negative aspect of Cloud Computing is that client cannot audit vendor's services for compliance. Cloud Vendors do not allow security/compliance or any sort of audits to be carried out by prospective clients or their representative (Armbrust *et al.*, 2010). There are several complications in auditing Cloud services, evaluation of services is a complicated task, auditors lack sufficient expertise in Cloud environment and the variable assessment methods make vendor comparison difficult (Borenstein & Blake, 2011). Major Cloud vendors however do provide prospective clients with the certifications they have achieved (Farrell, 2009). However, many IT Managers find these certifications insufficient, as most of the certifications are self-certifications (Khajeh-Hosseini *et al.*, 2011).

- Cloud services are prone to failure and vendor provides no assurances about their services. The lack of responsibility from vendor in case of any failure is a challenge that strains the client-vendor relationships, as there is a constant threat of service outage (Janssen & Joha, 2011). Unavailability of Amazon services caused huge losses to client, sparking calls for compensation but Amazon refused to compensate as they were (and are) protected in case of service failure (Subramanian, 2011).

3.3.3 Environmental Issues

Environmental issues are the issues related to the environment in which an organisation operates as these issues have an impact on technology adoption (Davis, 1989). These environmental issues are beyond organisational control. Legal or Compliance issues in migrating to or accessing Cloud Computing is the environmental issue reported in *44% of the papers* and is considered a key challenge in adoption of Clouds.

Legal or Regulatory compliance is a concern as there are national, international and regional laws enforcing data's physical placement bounds, data security and restrictions that conflict with very nature of Cloud technology. Privacy compliance rules are more stringent in UK and EU giving an individual rights to access, remove and destroy their personal data (Antonopoulos *et al.*, 2010). For an organisation in UK, this is challenging when using Public Clouds, as in US the user lesser control over their own data (Antonopoulos *et al.*, 2010). There are risks associated with international data storage and processing as major Cloud vendors are international organisations with extensive network of geographically distributed datacentres across the globe (Antonopoulos *et al.*, 2010). Regulations of a country where the data center is located can have jurisdictional conflicts i.e. USA's law that requires disclosure of private data to US government agencies is in contradiction with EU laws on Data privacy (Antonopoulos *et al.*, 2010).

Besides, issues of clarity of legal jurisdictions, interpretations of certain laws deter Cloud adoption. Antonopoulos et al. (2010) considers EU's data protection laws as barrier to adoption of Clouds as it forces data to be physically kept within the geographical bounds of European continent, making its compliance impossible for medium-scale Cloud vendor based in US. While on one hand the regulation are overbearing on companies willing to adopt Clouds, lack of legal framework forces companies to avoid adoption of Clouds on the other hand. Luoma & Nyberg (2011) report that the reluctance of Chinese executives in implementing Cloud was due to absence of the Chinese regulations , creating uncertainty.

Compliance with specific laws such as Sarbanes-Oxley Act or HIPAA Act creates barriers for financial or medical institutions making compliance a daunting task (Khajeh-Hosseini *et al.*, 2012). In most cases the IT Manager has to act as the Compliance Manager and is legally responsible for

meeting the terms of applicable regulation, regardless of any contracts with any third-party organisations (Subashini & Kavitha, 2010). This additional burden forces IT Managers to consider putting off the adoption of Clouds.

3.3.4 Security & Data related concerns

Different segments of people (i.e. as end-user, IT staff and IT Manager) working in an organisation have different concerns about Clouds in their own perspectives. These concerns are grouped as Data/Service related and Security related concerns. The key challenges in each thematic grouping are tabulated in the following table.

Table 19 Data, Service & Security concerns

Data, Service & Security concerns			
Themes	**Key Challenges**	**Frequency**	**Reported in % of papers**
Security Concerns	Security concerns/apprehension about Cloud Computing	15	60%
	Cloud vendor's vulnerability to cyber attacks	4	16%
Data & Services related concerns	Availability of service/Cloud vendor	7	28%
	Privacy of data stored on Cloud	9	36%
	Integrity of data hosted on Cloud	5	20%
	Reliability of services offered by Cloud Vendor	13	52%

Total number of papers in SLR n=25

Consistent with general perception, Security is a major concern mentioned in studies, discouraging adoption of Clouds. Security related concerns extracted from publications are clustered as client's security concerns and client's vendor related security concerns. The key challenges reported as security concerns are

- Security concerns/apprehension about Cloud Computing
- Cloud vendor's vulnerability to cyber attacks

The security concerns are in the context of employees in an organisation. IT Manager/IT staff have different views from ordinary end-users.

IT Managers are concerned that migration on Clouds would force them to add more security that adds operational complexities. Migrating services and data on Clouds has security risks such as SQL injection attacks, Cross-Site scripting attacks and Man-in-the-Middle attacks that require deployment of various tools for protection (Dillon, Chen & Chang, 2010; Subashini & Kavitha, 2010; Sultan, 2010).

The other aspect of security concerns relate to vendor's security and their vulnerability to cyber attacks. Operation Aurora, which was a coordinated cyber attack, aimed at major companies including established Cloud vendors such as Google and Amazon left a negative perception of vendor vulnerability (Zetter, 2010). On Clouds, the client is responsible for application-level security and the vendor is responsible for network-level and physical security (Armbrust *et al.*, 2010). Fear of traffic or user account hijacking is a security threat as network-level security lapse could allow hackers to imitate trusted user and corrupt data without even being noticed by the Client (Bisong & Rahman, 2011). Platform-level vulnerabilities at service layer of Clouds can cause insecure environments and are known to be prone to virtual machines level attacks. Security concerns associated with the hypervisor are immense as all the virtualised systems are controlled by it, and if a hacker gains control over the hypervisor then access to client data is possible (Armbrust *et al.*, 2010).

End-user's and IT Managers have several data related concerns such as data privacy, data loss, data leakage and data integrity. Data privacy breach is a reason for not choosing Public Cloud services and is a primary concern of both IT Managers and End-users. There are concerns about the presence of employees with malicious intentions at the Cloud vendor that can compromise data confidentiality, data security, data integrity and its availability (Dawoud, Takouna & Meinel, 2010). Armbrust *et al.* (2010) consider "vendor malfeasance" as a security concerns as the data eventually lies with the vendor and lapse at their part could result in data breach. However, this concern relates closely to trust on the vendor and the security policies it practices.

Data leakage comes with serious repercussions for organisations, its staff and its business. Placement of data on Public Clouds gives rise to fear of data leakage (Simalango, Kang & Oh, 2010). Customer's data is the major type of data that is leaked followed by confidential information (Gordon, 2007). It is common to hear news flash about stolen laptops, missing CD or lost USB memory sticks by the staff working at high profile organisations. These data leakages cause disruption of work and bad press. Besides reputational damage, if there is a personal data loss, then breach can result in financial penalties and civil liability claims (Gordon, 2007).

Antonopoulos *et al.* (2010) feels that storage abstraction inherit in Cloud technology raises end-users data privacy concern as it hides data's physical location. Other concerns reported in papers include the question of data integrity on Public Clouds and possibility of data loss in communication or storage (Kim *et al.*, 2009; Armbrust *et al.*, 2010).

Besides data, the service related concerns are about availability and reliability of Clouds. Planned service outages due to regular scheduled maintenance, as well as unplanned outages or downtime, both are considered as failure of service. Most of the vendors use specialised hardware and software, ensuring high availability of services but still failures happen and are beyond their control (Sarkar & Young, 2011). Besides outage, service failures, data access failure and other forms of failures also create hurdles in adopting Clouds (Sultan, 2010). Armbrust *et al.* (2010) notes that the "high-availability computing" community following the "no single point of failure" principal believes that management of a Cloud by a single company itself is a failure.

Reliability of Cloud Computing is defined as a probability of failure–free services offered over a specified period of time (Badger *et al.*, 2012). Reliability concerns are IT Managers' and end-users' perception about Clouds being unreliable. Most of the papers reviewed in SLR, broadly state reliability concern as barrier to adoption of Clouds. High profile outages of Amazon and Google Apps Engine are public knowledge and they create misconceptions about reliability, thus creating hurdles in adoption (Armbrust *et al.*, 2010; Simalango, Kang & Oh, 2010). Clouds' outages make organisations and end-users wary of Cloud Computing but they can be guided or informed about tolerable level disruptions.

3.4 Limitations of SLR design

How valid are the finding of the SLR? Common threats to validity of a systematic review are the possible biases in the selection process, study scope and data extraction inaccuracies. An internal validity threat to this study is slight personal bias and lack of expertise by the author. Although a single researcher (the author) performed the underlying search work, but the **second researcher (supervisor) was involved at multiple stages during the execution of SLR search and study selection, hence mitigating the chance of personal bias and compensating the lack of experience**.

Secondly, any specific article/paper accepted as part of SLR results may not have reported all the challenges in their published work. It is a plausible threat as authors have tendency to report only issues relevant to their arguments. Many of the papers that are part of the SLR results are based on self-reported experiences, case studies and empirical studies that may have subject or publication bias.

Thirdly, the higher order themes tend to have a research bias because the reviewer tends to develop a tunnel vision, which ignores other facts. **Author has tried to address this by triangulating different data sources of information in developing labels and used context in building themes.** Creswell (2009) affirms this fact that if themes are developed from several data sources or multiple perspectives then they would counter the threat of tunnel vision by the researcher, thus adding validity.

Finally, the key term search was conducted on databases that contained academic papers only, and hence this has effectively restricted the scope of the study to the academic domain. Some challenges reported in other forms (e.g. commercial reports etc.) might have been missed. Restricting study's scope to the academic domain is justifiable as **academic papers present data without conflict of interest and commercial bias**, which is not possible in commercial research.

3.5 Chapter Summary

The outcomes of this SLR are the key concerns and issues reported in literature that are deterring decision-makers from using/implementing/adopting Cloud technology in Enterprise environments. The results have highlighted security and reliability concerns, lack of compliance, lock-in issues, data privacy and difficulties in application and service migration as key challenges in the adoption of the Clouds. Fewer studies analyse the barriers in the adoption of Cloud Computing and majority focus on technical factors with less emphasis on environmental and organisational factors. All the empirical studies that were part of the SLR results were reviewed and grouped as fair or good evidence based on their strengths and weaknesses. Good evidence was seen in three studies (3 of 9) and rest of the 66% of empirical studies have weaknesses that made them fair evidence. This made the extracted data acceptable as evidence but lacked foundation on which theories or further work could be grounded. Thus, it was decided that the identified key challenges should be validated directly by IT Experts who have experience in adopting Clouds. Next chapter discusses the survey research conducted to validate the challenges and to elicit the practices that help in overcoming these challenges.

Chapter 4: Survey Results and Discussion

Introduction

This chapter presents the objective of the survey for this research, questionnaire design, sampling and dissemination of the survey questionnaire to target respondents.

The first section discusses the survey design, its targeted audience, questionnaire design and strategies used in dissemination of survey. The second section discusses the data collected from the survey. Results include key adoption challenges of the Enterprise Clouds and the industrial approaches for overcoming the challenges. The data from the survey response contributes two important things to this research; it validates the key challenges and elicits the tacit knowledge about practices. Statistical analysis is carried out on data set, comparison form multiple source, gaps and interesting finding are analysed, discussed in last sections.

4.1 Survey Design

Collection of information from experienced practitioners with specific experience in deployment of Enterprise Cloud Computing required collection of information from large number of people in limited time and resources. Survey method was considered as a suitable choice amongst others methods (i.e. Expert interviews, focus groups etc.). Survey research as a method is described as a “comprehensive system” to describe, compare or explain knowledge, attitudes and behaviour of large group of people (Barbara & Shari Lawrence, 2003). The advantage of survey is that it produces real world observations or empirical data, has breadth of coverage of many people and events and produces a large amount of data in a short time and helps in the completion of research project within the defined timeframe (Kelley *et al.*, 2003).

The survey research was conducted with two objectives 1) validate the finding of the SLR from the practitioners experienced in the implementation of Cloud Computing in an Enterprise environment and 2) elicit the practices that help practitioners in overcoming these adoption challenges.

This study used a hosted questionnaire whose link was sent to the respondents. The following sections explain the targeted industrial sector, instrument design, data collection strategy and its execution.

4.1.1 Targeted industrial sector & Respondent grouping

Technology implementation is a complex issue that requires knowledge from people with expertise in understanding different organisational, operational and technical issues. Therefore, the survey targeted practitioners working in Enterprise IT environment having experience in the deployment of Enterprise Cloud Computing services. Questionnaire designed for targeted participants leads to better results (Stewart & Stasser, 1995).

A dominant approach in earlier surveys studies (Benlian, Hess & Buxmann, 2009; Heinle & Strebel, 2010) in Cloud Computing domain is to approach clients of Cloud vendors for potential participation. Following this approach, Cloud vendors' (such as Google, Microsoft, Amazon, Rack Space, IBM Cloud, HP Cloud, Adobe Cloud etc.) reference/case studies profiles were studied to extract information about the industrial sector from which their clientele originate. Although no complete and comprehensive list of client was available publicly, perhaps due to commercial sensitivity of the information, the most discussed clientele is of Education Sector with Higher Education Institutions (HEIs) as a special focus.

In comparison to other vendors, Google Inc. is most open in sharing information and publishing client profiles, reporting on industrial segments through publication of case studies, success stories etc. Google has focused on Higher Education Institutions (HEIs) as a target market since year 2006 (Google Inc, 2006). Their initial offering was hosted email services (GMAIL) to small business and schools but in 2006, Arizona State University in USA adopted services by offering email, calendar and instant messaging services to their 65,000 students (Google Inc, 2006). Arizona State University, later integrated their user directory, single sign-on systems and e-mail gateways with Google's services (Google Inc, 2006).

Google Apps for Education (recently rebranded as Google for Education) evolved from hosted email services (Gmail) to software services (including productivity software), data storage, development platform and infrastructure services, offered free of charge to registered charities, universities, colleges and schools. The same set of services is offered as Google for Work (Google Enterprise class public cloud services) to Enterprise scale clients for a fee (per user per year). Microsoft Corporation's initial Cloud services were Windows Server Virtualisation platform

(Windows Azure, Windows Azure Cloud) which was offered to clients with other application licences (Simmhan *et al.*, 2010). Since year 2013, Microsoft in Education offers desktop based MS Office software to Cloud-based Office-365 services on discounted rates to students and universities (Microsoft, 2016). The services offered on public Clouds remain the same across all service consumers with difference in service level agreements (SLAs) and customer services. However, both types of customer organisations (free and non-free) use the same services and infrastructure offered by Google Cloud or Microsoft Cloud (Google Inc, 2012). IT services offered by Higher Educational Institutions are Enterprise class in scale and quality, hence considered as client using or accessing Enterprise Clouds.

In proceeding paragraphs the term IT Practitioners is used as standard terminology for IT people who are employed/engaged to work within either IT companies or any client organisations in any industrial or service sector. IT practitioner is defined as

> *"[…] someone who designs, develops, operates, maintains, supports, services, and/or improves IT systems, in support of End-Users of such systems." (Dixon, 2002).*

The IT practitioners, working for HEIs or working as Cloud deployment supporting Enterprise Cloud deployment for clients were targeted as respondent to ensure a mix of potential respondents.

Potential respondents were divided in two groups (A & B) based on their job role, employer and experience in deployment of Enterprise Cloud and are referred as:

- Group A: IT staff member, employed by an Educational Institution (UK or Globally) with Cloud deployment experience/expertise.
- Group B: Cloud Deployment Experts, Consultants, Cloud Apps Trainers with Cloud deployment experience.

Adding IT practitioners at Cloud deployment service providers helped in ensuring that single view from HEIs would not be the dominant view.

4.1.2 Questionnaire Design

Kelley *et al.* (2003) suggest that it is better to adapt an existing research tool rather then starting from scratch. Ehie & Madsen (2005) used a questionnaire that asked experts to rate significance of critical issues in enterprise resource planning (ERP) implementation and Khan, Niazi & Ahmad (2012) used a questionnaire asking outsourcing experts on the critical success factors. Both questionnaires were piloted as an instrument (Ehie & Madsen, 2005; Khan, Niazi & Ahmad, 2012).

The questionnaire (Refer to Annexure D) designed in this survey adapts the questionnaire design approach from Khan, Niazi & Ahmad (2012) yet maintain its own uniqueness considering the objectives of the research and available resources.

The survey questions aim to validate the key challenges that were extracted from systematic literature review carried out in the earlier phase (Chapter 3). The questionnaire was divided into three sections 1) the questions on the challenge faced by IT practitioner in adoption of Enterprise Cloud Computing 2) the practices/actions applied/used to overcome the adoption challenges and 3) the demographic questions. The wording for some questions differs for both groups as Group A were asked questions in context of their organisation/employer whereas Group B were asked in context of their clients.

The first section was related to the challenges identified through the SLR study. The respondents were asked to select scale of agreement of disagreement on a Likert scale for each issue listed (i.e. Strongly Agree, Agree, Strongly Disagree, Disagree or Not Sure). Open-ended questions were asked to elicit more issues or factors not raised earlier. Second section asked questions with the objective to extract tacit knowledge about the practices that helped IT practitioners in overcoming the adoption challenges. Third and last section had questions related to respondents' demographics.

Kelley *et al.*, (2003) suggest researchers to pilot their questionnaire to validate its efficacy and effectiveness. The developed survey instrument was piloted within PhD Computing research group and with IT staff members of Keele University, UK. The feedback from piloting exercise was instrumental in removing ambiguities in language. After piloting and feedback, several small design

considerations were added in questionnaire i.e. open questions were asked before closed questions to avoid influencing the respondents with survey terminology. Moreover, the answer of close-ended questions appeared in randomised order so as to avoid selection bias by respondents.

A traditional paper based questionnaire was designed initially, which was converted to an online-hosted survey. The survey was hosted on Lime Survey, an open source web survey-hosting platform.

4.1.3 Survey Dissemination Strategy and Execution

The sample was drawn using a random sampling from a population of IT experts with cloud deployment experience. Though the drawing sample from the targeted population involves assembling people with known experience and expertise in some area, yet every effort was made to ensure randomness of respondents. The drawn sample represents the Cloud experts with the experience of deploying Enterprise Cloud.

The experience of deploying Enterprise Cloud is defined as a position where an IT person has been involved as a leader or part of a team, or has lead, managed, worked, or supported in deployment of new IT services or migrated existing IT services to Enterprise Clouds.

To ensure that survey questionnaire reached all potential respondents, a list of IT Managers and Cloud Technology Experts was compiled using online resources and professional forums. The majority of contacts and participation commitments came from two forums:

- University Colleges Information System Administration (UCISA),
- Google Apps for Education User Group.

UCISA represents major UK Universities and Higher education institutions sharing examples of good practice, raises awareness of technology developments and act as a voice on IT issues within the HEI's Information Technology management community. UCISA's has a special interest group that maintains active mailing lists and networks, and arrange seminars.

Google Apps for Education User Groups was a group of Google Apps for Education users, led by Loughborough University UK had its first meeting in year 2011. This group had 126 members

(where 102 were from HEIs, 9 from Further Educational Institutions, 8 from Google Inc. and 7 people from others organisations) who are Cloud deployment specialists, Systems developers, IT Managers and Technology specialists who shared their experiences of implementing Google Apps for Education in the UK in year 2012. This group later evolved into Google Apps for Education European User Groups (GUEG) with European professionals participating in GUEG 13 and GUEG 14 conferences held in University of Portsmouth UK and University of York respectively.

IT Practitioners working in HEIs were approached using mailing lists of UCISA's Interest Groups i.e. Project & Change Management Group, Networking Group and Infrastructure Group. Cloud deployment experts were approached using LinkedIn Groups, being an industry professionals' preferred forum.

LinkedIn Group members of following groups were invited to participate in survey:

- Microsoft Cloud Deployment network Community
- Amazon Cloud Developers Community
- Google Apps for Enterprise Users Community
- Google Apps Trainer Community
- Edu in Cloud Community
- Google Enterprise Deployment Partners Community.

Email invitations requesting participation were sent to IT practitioners from the contact database and to increase the response rate of the survey social media was used. Social chat and survey dissemination increased with marketing campaign on Twitter and LinkedIn networks to promote survey link to targeted participants.

Networking activities such as attendance of industrial seminars and talks were also used. I attended two industrial seminars, Google Apps for Education North of England Summit, Halifax and AppsCare - Google Enterprise Executive Seminar as participant that helped me in developing an understanding of IT practitioners' practices and gaining commitment from potential survey

participations. These forums provided opportunity to have conversations with industry professionals about their personal experiences and the adoption strategies.

In Year 2014, I participated in GUEG-14 conference held at York University in UK, where I set up an information kiosk for my survey, gave a small talk on the survey and my PhD work. Several IT practitioners responded to the questionnaire at the stall.

4.2 Results

The following sections present the responses in tabular form with graphical representations including respondent profiles, responses and key challenges in adoption of Enterprise Clouds.

4.2.1 Response rate

The survey was launched in November 2013 and was closed in July 2014. During this time total 163 people were sent emails directly. In June 2014, a kiosk in Google Apps for Education European User Group Meeting at York University, UK was set up and there another 10 participants were approached. In total 173 potential participants were approached. The number of people that responded to the survey was 59 (34% over all response rate) out of which 47 answered the survey completely, thus 47 were finally selected as valid responses.

The useable data set is of 47 responses making it 27% of the total 173 survey participants approached. The responses provide the empirical basis of the data analysis of the challenges in the adoption of Enterprise Cloud Computing.

4.2.2 Respondents' profile

The survey participants were asked questions that requested them to identify their job roles, employers and their personal experience. The first question asked in the survey was about the job role, employer and experience in implementation or deployment of Cloud Computing services.

From total 47 responses, 22 participants identified themselves as IT practitioners working in Educational Institutions with experience in deploying or supporting Cloud Computing deployment. The rest of 25 respondents identified themselves as Cloud App developers/ Trainers (6 respondents), IT Consultants (9 respondents) or IT Practitioners working for IT companies providing deployment services (10 respondents). The respondents were segregated into groups based on the response of this question.

Table 20 Respondent's Job Role, Employer & Experience

Job Role, Employer and Cloud Deployment Experience		
Response	**Response Count**	**%age**
IT Practitioner working at Educational institution	22	47%
Cloud Apps Developer/Trainer	6	13%
IT Consultant providing Cloud deployment services	9	19%
IT Practitioner/Staff employed by IT company	10	21%
Total	47	

**Percentages are rounded off*

Years in current job are taken as a measure of expertise of the participants (Ehie & Madsen, 2005). Overall, 36 % (highest percentage) respondents are working in their job role/capacity for 3 to 5 years, followed by 32 % who are in their job role/capacity for 1 to 3 years.

Table 21 Years in current job/role

Years in current Job/Role		
Years	**Count**	**%age**
More than 5 years	10	21%
3 to 5 years	17	36%
1 to 3 years	15	32%
less than a year	5	11%
Total	47	

The overall trend reflects that a sizable number of respondents (32) are working in their job roles/capacities for 1 to 5 years, in which they have deployed or supported deployment of Clouds or are working with Cloud environment. Detailed respondent profile is given in Annexure C.

4.2.2.1 Group A: IT Practitioner working at Educational Institution

IT Practitioners with Cloud deployment experience employed at Educational Institution in UK or globally are grouped under Group A (n = 22).

Seven participants from Group A identified themselves as IT Managers, 5 as System Administrator, 3 as IT Support, 2 as Implementation Manager and 1 each as IT Director, ICT Teacher and Other job titles. Two respondents chose not to answer the question. The following pie chart represents Group A's percentage distribution of job titles or roles.

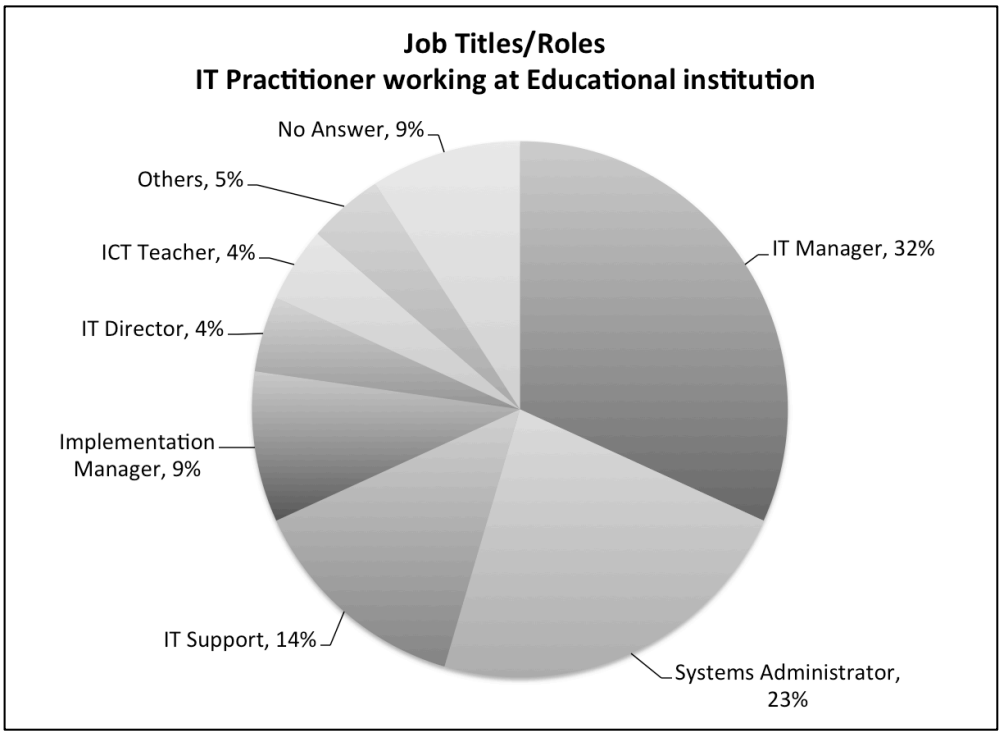

Figure 10 Chart: Group A's percentage distribution of job titles

A total of 17 participants are employed at Universities, 3 are employed at Higher education institutions that include college and degree granting institutes, and 1 respondent each from Further Educational Institution (FEI) and secondary school. Participants from Universities (77% of the total 22 participants) dominate Group A.

Table 22 Employers' Type of Educational Institution

Employers' type of educational institution		
Group A respondents only (n=22)		
Types	**Count**	**Percentage**
University	17	77%
Higher Education Institution (HEI)	3	14%
Further Educational Institution (FEI)	1	5%
Secondary School	1	5%
Total	22	

**Percentages are rounded off*

The number of workstation managed by IT department represents the size of IT organisation. Around 68% of the IT practitioners work within IT department manage more then 500 workstations and 31% manage workstation between 100 to 500 stations (See Table 23). The term workstation count is that of desktop systems used in IT labs, including teaching and administrative

staff's PCs. Managing University's peripherals is merely a small fraction of the actual workload for IT staff members as now they also provide services to end-user's laptops, tablets and mobile devices.

Table 23 Number of workstations managed

Number of Workstations managed by IT department		
Group A respondents only (n=22)		
Number of Workstations	**Count**	**%age**
More than 500	15	68%
Between 100 to 500	7	32%
Less than 100	0	
Total	22	

**Percentages are rounded off*

Almost 60% of the respondents (13 of 22) reported that their institution migrated services or deployed Cloud Computing in year 2012. The earliest adoption of Clouds was carried out in year 2007 (See Table 24)

Table 24 Year of Cloud deployment

Deployment year of Cloud Computing		
Group A respondents only (n=22)		
Year	**Count**	**Percentage**
2007	1	5%
2010	3	14%
2011	4	18%
2012	13	59%
2013	1	5%
Total	22	

**Percentages are rounded off*

4.2.2.2 Group B: Cloud Deployment Experts

Group B comprises of 25 respondents (n = 25) that identified themselves as IT Practitioners, Cloud Application Development Experts, Cloud Application Trainers, IT Consultants and IT staff working for Cloud deployment services/organisations. This group of respondents either are employed by vendor partnerships or work with clients independently.

Nine respondents identified themselves as IT Consultant from a total of 25 respondents, 2 as CEOs, 4 as IT Managers, 1 as IT Director and 3 respondents reported other job titles i.e. Project Manager, Network Analyst and Business Analyst, whereas 6 respondents chose not to respond to this question. The following pie chart presents Group B's responses (See Figure 11).

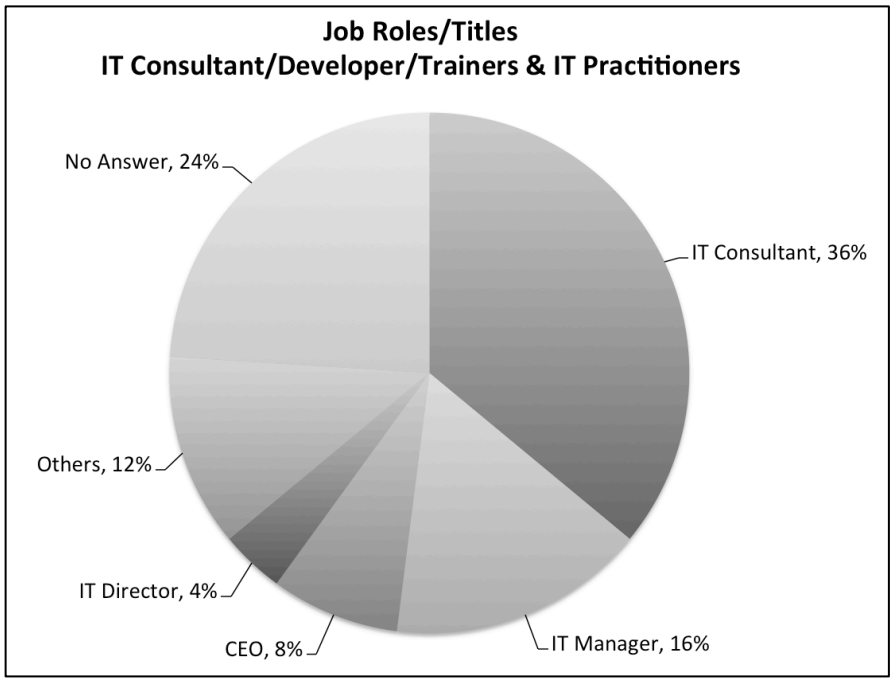

Figure 11 Chart: Group B Job titles percentages

When asked about the industrial segment in which the company or consultants work, the majority reported that their clients belong to Education sector, followed by wholesale and retail sector and other industrial segments. (See Table 25)

Table 25 Clientele's industrial segment

Clientele's industrial segment		
Group B respondent only (n = 25)		
Industrial Sectors	Response Count	%age
Education	10	40%
Wholesale & Retail	9	36%
IT & Telecommunication	7	28%
Manufacturing	5	20%
Financial & Business services	3	12%
Public Administration & Defence	2	8%
Others	7	28%

Participants in Group B were asked to provide the average number of end-user's encountered at their clientele. Fourteen respondents reported that their client's have an average of more than 500 end-users and 5 reported client's size between 100 to 500 end-users (See Table 26).

Table 26 End-users at Client organisations

Average number of End-users at client organisations			
Group B respondents only (n=25)			
No of End-users	**Count**	**Percentage (Valid)**	**Percentage (Total)**
More than 500	14	74%	56%
Between 100 to 500	5	26%	20%
Less than 100	0		0%
No Answer	6		24%
Total	25		
**Percentages are rounded off*			

Typically, large-scale customers engage IT Consultants or Vendor partners. Highest percentage of the response is in the category of "More than 500 end-users" makes it the largest group within the valid response.

4.2.3 Impact of adopting Enterprise Clouds

The survey asked the respondents to identify the goals and drivers in adoption of Clouds. The respondents in Group A answered this question in context of their own institutional goals whereas Group B's responded about their client's drivers for migrating IT services on Clouds.

For Group A the top most responses are the goals to reduce operational expenses, bring flexibility in IT resources, avoid capital expenditure, overcome IT staff capability deficiencies etc. It would be pertinent to mention that majority of Clouds services specially email hosting, storage and backup services come either free of cost or at a very low prices to educational sector.

For Group B the top drivers behind their client's decision to migrate to Clouds are avoidance of capital expenditure, reduction of operational cost, acquire flexibility of resources and an increase in computing capacity. Clouds in commercial environment offer rapid scalability and saving in capital expenditure particularly for companies with growing IT needs (See Figure 12).

The others drivers stated by the respondents are "Features", "Far the most important! Improve teaching and learning", "Reduce energy use", "Provide new MIS service" and "Change Legacy System".

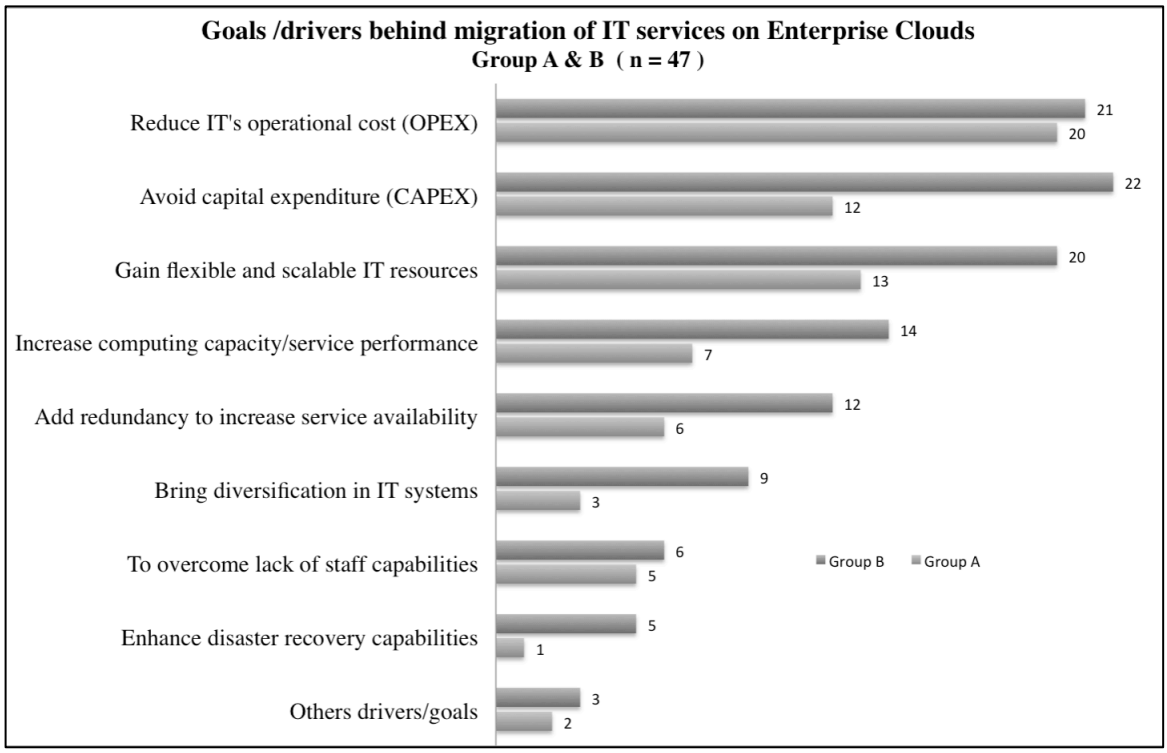

Figure 12 Chart: Goals behind migration to Clouds

European Network and Information Security Agency (ENISA) conducted a survey on migration of Clouds from small and medium scale (SMEs) organisations in year 2009. They asked a question *"What are the reasons behind your possible engagement in the Cloud Computing area?"* and their 68% of respondents said that "avoiding capital expenditure in hardware, software, IT support, information security by outsourcing infrastructure/platforms/services" and 63.9% choose "flexibility and scalability of IT resources" (European Network and Information Security Agency ENISA, 2009).

Group A and B's response to a similar worded question seems *consistent* with that of ENISA's responses thought here organisational size is of Enterprise scale. In this survey 87% respondents chose "reduce IT's operational cost" and 72% of respondents chose "avoid capital expenditure" as driver behind their Enterprise to migrate to Clouds.

The next question in the survey questionnaire asked "Did the institution achieve any significant reduction in software licensing fees or IT hardware costs after migration of services on Clouds?". A similar question "Did the client organisations manage to bring about a significant reduction in software licensing fees or IT hardware costs after migration of services on Clouds?" was asked from Group B.

Table 27 Reduction in operational cost

Reduction in IT operational costs after migration of IT services on Clouds						
	Group A (n=22)		**Group B (n = 25)**		**Total**	**%valid**
Answers	**Response**	**% valid**	**Response**	**% valid**		
Yes	12	63%	18	78%	30	71%
No	7	37%	5	22%	12	29%
No Answer	3		2		5	
Total	22		25		47	

**Percentages are rounded off*

In total, 71% (30 of 42 responses) of overall valid responses said yes to the questions (See Table 27), however Group A's naysayers are higher than Group B's (37% > 22%). This slight difference can be interpreted as higher expectation of cost reduction in Universities or HEIs after migration. Perhaps the savings from migrating to Clouds seem insignificant to Universities or HEIs as they already get heavily subsidised applications/software licences.

The migration of application or service on Clouds impacts the organisational and its departmental processes. Empirical studies (Greenwood *et al.*, 2010; Sarkar & Young, 2011) focusing on migration of application or services on Clouds in Universities reported changes in vendor management process, IT communication process and end-user account management process. Benlian & Hess (2011) reported that majority of IT executives changed existing end-user feedback system for new Cloud based services.

The survey asked about the processes that were changed after migrating/deploying Clouds. Processes changed after adoption of Clouds are: vendor management, feedback process, IT communication, End-user IT account creation, teaching and learning process and IT Management process (See Table 28).

Table 28 Processes changed after Clouds deployment

Organisational/Departmental processes changed after Cloud deployment				
Group A and B (n = 47)				
Org/Dept. processes	**Group A (n = 22)**	**Group B (n = 25)**	**Total**	**%age**
End-user IT account creation	19	20	39	83%
IT communications process	18	17	35	74%
Feedback process	13	21	34	72%
Vendor management process	3	15	18	38%
Others - Teaching and learning process	1		1	2%
Others - IT Management processes		1	1	2%
No change in any process (N/A)	3	2	5	11%

**Percentages are rounded off*

End-user IT account creation, IT communication and Vendor management process are reported by a sizeable majority of respondents as processes that are changed after deployment of Clouds. The process of end-user account creation for Cloud services is inevitably changed as this is done using vendor's control panel. Google Apps, Microsoft both support single sign-on (SSO) implementation for user authentication yet user account creation is done through Cloud based API.

IT Service Management (ITSM) communications are an important part of IT service management as it engages stakeholders and IT customers. If new systems are deployed or existing ones are changed then it is necessary that stakeholders are kept informed by regular communications about the current status of project, its impact on existing services, future plans on testing and training for the new services (Iden & Langeland, 2011). Periodic daily reports, performance reports on services or IT components and internal IT communication such as Service Level Agreements (SLAs) and Operating Level Agreements (OLAs) are changed with new services (ITIL, 2013).

COBIT (Control Objectives for Information and Related Technologies) is a good-practice framework developed by Information Systems Audit and Control Association (ISACA) for IT management and governance. In COBIT 5, ISACA has developed a complete set of vendor management practices focused towards Cloud vendors (Crowe, 2012). The guide states that "concept of Cloud Computing constitutes an important part of the vendor management scope" and "vendors have very specific cloud-related risk and challenges". Based on this principal it can be concluded that Cloud vendor relationships need newer processes. Only three (3) IT practitioners

from educational institutions have reported that their vendor processes are changed. This reflects that vendor management processes are not modified in educational institutions whereas the responses of the IT practitioners confirms that vendor management processes are changed at client organisation to manage the newly formed relationship between Client and Cloud vendor. *The vendor management processes should be updated to manage the new relationship in HEIs.* The educational institutes should follow this practice.

4.2.4 Educational IT's systems on Clouds and status

It is a common perception that most of the organisations that deploy Clouds primarily use Email hosting services. This perception may hold true in many cases but often Email hosting is the first step followed by migration of other services/systems on Clouds.

A question was asked in the survey about the IT systems that have been migrated on Clouds. Almost 100% of the respondents in Group A reported Students' Email on Clouds, followed by 91% reporting Staff's email, whereas only 5% stated that their institutional IT service desk management systems are on Clouds.

Table 29 IT system deployed on Clouds

IT system deployed on Clouds		
Group A respondents only (n=22)		
IT Systems	**Responses**	**%age respondents**
Students' Email	22	100%
Staff's Email	20	91%
Students' data storage	20	91%
Staff's data storage	18	82%
Virtual Learning Environment (VLE)	18	82%
Records Management System	12	55%
Content Management System	7	32%
MIS (including Finance/Payroll/HR/BI)	2	9%
IT Service Desk Management System	1	5%
Others	3	14%

**Percentages are rounded off*

Email is a primary IT service nowadays in any organisation and the first to go on hosted servers. The data reflects that most commonly migrated systems are email, storage, Virtual Learning Environment (VLE) but MIS systems or data intensive systems or legacy systems are still not the first choice for migration. Other systems reported by respondents are "website", "Student portfolios" and "Learning Management system".

Migrating email services on Clouds is mostly done by using Software as Services (SaaS) on Clouds. A question was asked to judge the focus of clients towards other cloud offerings such as Platform as a Service (PaaS) or Infrastructure as a Service (IaaS/ITaaS).

Group A was asked a question "Is your institution considering or using the Cloud platform services (PaaS) or Cloud IT infrastructure services (IaaS/ITaaS)?" to know about the status of PaaS and IaaS implementations in their institutions.

Choices were "no plan to use PaaS or IaaS service", "considering options", "developing business case", "currently implementing" and "completed implementation". For PaaS, it is observed that 33.33% of organisations have completed implementation however a sizable majority (60%) do not intend to use PaaS. The following table (See Table 30) reflects the figures of the status of PaaS and IaaS initiatives at Educational institutions.

Table 30 Status of PaaS or IaaS in Educational institutions

Status of PaaS or IaaS in Educational institutions				
Group A respondents only (n=22)				
Answers	**Platform as a Service (PaaS)**	**%age (valid)**	**Infrastructure as a Service (IaaS/ITaaS)**	**%age (valid)**
Completed the implementation	5	33.33%	2	14.29%
Implementation under way	0		2	14.29%
Business case being developed	0		0	
Considering options	1	6.67%	3	21.43%
No plans to use this service	9	60.00%	7	50.00%
No answer	7		8	
Total	22		22	

The limited use of PaaS at HEIs could be due to small number of HEIs carrying out software development activities themselves (or in-house). Low uptake of IaaS is also reflected in responses, as 50% of organisations have no plans to use IaaS whereas 14.29% of respondents reported completed implementations and 14.29% stated that they are currently in the process of implementation. Evidently, the above reported data set nullifies the notion that migrating services on Clouds in merely using hosted Email services from Cloud vendor. Beside Email, multiple IT systems are migrated on Clouds, Platform and Infrastructure services are in use within educational institutions supporting Enterprise IT services offered to the end-users.

4.2.5 Essential element of IT infrastructure for successful adoption of Clouds

In order to learn from the experience of the IT practitioners, open-ended questions asked them to share their knowledge and expertise. A question asked survey participants about the essential element of the IT infrastructure required for successful migration of IT services to Clouds. The elements of IT infrastructure are operating system, software, networking equipment, hardware etc. The respondents share that they feel that provision of stable, reliable, fast Internet connection, Wi-Fi, flexible robust filtering, open source operating systems, web browsers with Enterprise Management Support is essential to successful adoption of Clouds. The collective premise emerged out of all the responses is that highly reliable and fast Internet connection is an essential in IT infrastructure for successful migration of IT services on Clouds.

In the SLR results (refer Chapter 3 section 3.1), it was noted that Cloud implementation suffers due to lack of suitable IT infrastructure including high-speed Internet connectivity and virtualisation technology (Luoma & Nyberg, 2011). Up gradations are required at times to bring existing network at par with the requirement of newly deployed Cloud services, though research have reported reluctance on part of client to invest in up gradation (Khajeh-Hosseini, Greenwood & Sommerville, 2010). However, these responses verify that provision of high-speed Internet connectivity is an essential factor in success of Cloud deployment and missing this would become an issue that would create adoption challenge.

A sceptical view to these responses is that what defines fast Internet and how much bandwidth makes it fast. Fast Internet depends on abundant bandwidth available for all services on Clouds and other organisational needs. A survey participant concurs this that there is no magic number for Internet size and speed, as “Exact values will depend on what you are using from the Cloud and how you are using it – e.g. web based email will use a lot less than downloading, editing and uploading CAD drawings” (Respondent9). Bandwidth needs for Clouds can be determined by a general rule of thumb, 100 kilobits per second per user is sufficient for accessing Public Cloud and using Cloud service based services such as e-mail, collaboration tools, and CRM (Bright, 2013).

4.2.6 Practitioner perceptions on adoption challenges

The overarching aim of this research survey was to elicit the experiences of the IT practitioners on the challenges faced by them while deploying Enterprise Clouds. The survey answers this research question by asking the IT practitioners to share the issues they faced during migration of services on Clouds or deployment of new services. The responses helped in validating the finding of the SLR through IT practitioners' experience. The following section discusses the issues and concerns that are considered challenges in deployment of Cloud by respondents.

4.2.6.1 Issues as a challenge in deploying IT services on Cloud Computing

One question in the survey presented a list of issues and asked respondents to rate their agreement or disagreement about each issue as an adoption challenge. The wording of the question requested the participants to base their response on their experience. The list of issues as response choice was the set of issues identified through the SLR (Refer to Chapter 3 Section 3.3) as the challenges in adoption of Clouds.

The participants were asked to rank each issue on a five-point Likert-type scale (Strongly Agree-SA, Agree-A, Neutral – N or Not sure-NS, Strongly Disagree-SD, Disagree–D) to determine the perceived importance of each issue as a challenge in adoption of Clouds.

This five-point scale was transformed into three-point scale by

- Summation of strongly agree and agree scales as ***agreement***,
- Summation of strongly disagree and disagree scales as ***disagreement*** and
- Summation of Not sure/Neutral response as ***neutral***.

The agreement reflects as IT practitioners agree that a specific issue is a challenge and the count describes the relative importance of the issue. The disagreement is IT Practitioners' perceptions about significance of an issue as a barrier to the Cloud adoption but not rejection of existence of the issue.

The top five issues on which all respondents (Group A & B n = 47) have either agreed or strongly agreed as a challenge to adoption of Clouds are (See Table 31):

- End-user resistance to change – 83% of respondents (39 of 47 responses)
- Legal or Compliance issues in migrating to or accessing Cloud Computing – 79%
- IT Staff's resistance to change – 72%
- Incompatibility of existing IT Infrastructure/Resources for Cloud Computing – 68%
- Lack of organisational readiness – 57%

The top five issues ranked by percentage disagreement by Group A and B respondents are listed below along with percentage of responses (See Table 31 for more details).

- Difficulty in determining Cloud Vendor's long-term viability or sustainability (77% of 47 responses)
- Lack of sufficient migration support from Cloud Vendor (70%)
- Lack of client's right to audit Cloud Vendors' services or security protocols (68%)
- Difficulties in Application/Service migration to Cloud Computing (62%)
- Increase in IT Department's operational cost (57% of responses)

The question also recorded respondent's neutrality. The top five issues ranked by highest percentage of neutral choice are "Increase in IT Dept.'s operational cost", "No indemnity for service failure by Cloud Vendor", "Lack of QoS or SLA monitoring solutions", "Decrease in service performance after migrating services on Cloud Computing" and "Lack of client's right to audit Cloud Vendors' services or security protocols" (See Table 31).

The increase in IT department's operational cost is an issue disagreed by majority with high neutral opinions too, implying it as an issues with mixed views. The calculation of operational

costing related to IT department is complicated and the calculation factors can vary across organisations (Greenwood *et al.*, 2010). Earlier research (Kim *et al.*, 2009; Dawoud, Takouna & Meinel, 2010) suggested increase in IT operational cost as an adoption issue, however this view is not supported by the IT practitioners' perception as very low number of respondents (only 11%) agreed with it as a challenge, whereas majority either rejected it or expressed their inability to comment as a barrier to adoption of Clouds.

Table 31 Issue as a challenge in Cloud Deployment

Issues/Factors as a challenge in Cloud Deployment						
Respondents *(n=47)*						
	Agreement		**Disagreement**		**Neutral**	
Issues/Factors	**Response (SA+A)**	**%age of respondents**	**Response (SD+D)**	**%age of respondents**	**Respons e (N)**	**%age Neutral**
Decrease in service performance after migrating services on Cloud Computing	12	26%	23	49%	12	26%
Difficulties in Application/Service migration to Cloud Computing	9	19%	29	62%	9	19%
Difficulty in determining Cloud Vendor's long-term viability or sustainability	6	13%	36	77%	5	11%
End-user resistance to change	39	83%	7	15%	1	2%
Excessive effort is required to re-engineer legacy applications for migration on Clouds	25	53%	12	26%	10	21%
Incompatibility of existing IT Infrastructure/Resources for Cloud Computing	32	68%	12	26%	3	6%
Increase in IT Dept.'s operational cost	5	11%	27	57%	15	32%
Increased dependence on a third party provider	24	51%	19	40%	4	9%
IT Staff's resistance to change	34	72%	10	21%	3	6%
Lack of client's right to audit Cloud Vendors' services or security protocols	4	9%	32	68%	11	23%
Lack of interoperability between Cloud service or Cloud Vendors	21	45%	20	43%	6	13%
Lack of organisational readiness	27	57%	16	34%	4	9%

Issues/Factors as a challenge in Cloud Deployment						
Respondents *(n=47)*						
	Agreement		Disagreement		Neutral	
Issues/Factors	**Response (SA+A)**	**%age of respondents**	**Response (SD+D)**	**%age of respondents**	**Respons e (N)**	**%age Neutral**
Lack of QoS or SLA monitoring solutions	8	17%	26	55%	13	28%
Lack of sufficient migration support from Cloud Vendor	9	19%	33	70%	5	11%
Legal or Compliance issues in migrating to or accessing Cloud Computing	37	79%	7	15%	3	6%
Loss of control over IT resources after migration on Clouds	25	53%	18	38%	4	9%
No indemnity for service failure by Cloud Vendor	11	23%	22	47%	14	30%
Vendor /Service lock-in issues	12	26%	24	51%	11	23%

**Percentages are rounded off*

SA Strongly Agree, A Agree, SD Strongly Disagree, D Disagree, N Neutral

After comparing the inter-group response, it is visible that there are minor variations on issues.

The issue "Excessive effort is required to re-engineer legacy applications for migration on Clouds" is in top five in Group A response, (46% of respondents reporting it) but this issue is not part of Group B's top five issues (although reported by 60% of the respondents of Group B). Vice versa "lack of organisational readiness" is reported by 76% of Group B's respondents but still it is not part of Group A's top five issues (See Table 32)

The lack of organisational readiness is a challenge in Clouds deployment and is agreed by 36% of respondents of Group A in comparison to 76% of Group B's respondent agreement. IT practitioners at Educational institutions do not consider lack of organisational readiness as a

significant factor that acts as barrier in the Clouds deployment. Groups B's respondents work with multiple sectors and perhaps their experience tells them that their clients are not ready to take on Clouds.

The issue of incompatibility of existing infrastructure and IT resources (16 of Group A's 22) is stated by significantly higher number of Group A's respondents in comparison to B's responses (73% > 64%). This can be interpreted that IT staff at educational institutions feels that their IT infrastructure is incompatible with Clouds, an opinion that not shared by their commercial counterparts (See Table 32).

Table 32 Top 5 issues agreed as a challenge in Cloud Deployment

Top five Issues/Factors as a challenge in Cloud Deployment						
Issues/Factors	**Group A (n = 22)**			**Group B (n = 25)**		
	Agreement Count	**%age within group**	**Rank within Group**	**Agreement Count**	**%age within group**	**Rank within Group**
End-user resistance to change	17	77%	***2***	22	88%	***1***
Legal or Compliance issues in migrating to or accessing Cloud Computing	18	82%	***1***	19	76%	***3***
Incompatibility of existing IT Infrastructure/Resources for Cloud Computing	16	73%	***3***	16	64%	***5***
IT Staff's resistance to change	13	59%	***4***	21	84%	***2***
Lack of organisational readiness				19	76%	***3***
Excessive effort is required to re-engineer legacy applications for migration on Clouds	10	45%	***5***			

**Percentages are rounded off*

End-user resistance and IT staff resistance to change are two factors that are part of the top five factors agreed by IT practitioners as adoption challenge but a look at Group A's data reveals that these two factors are comparatively lower than Group B's response. End-user resistance is agreed by 77% of Group A's respondents whereas the same is agreed by 88% of respondents in Group B.

The issue of "IT staff resistance to change follows the same trend where Group A's agreement is lower than Group B's but this difference is not very significant as 59% of Group A respondents agreed to this in comparison to 84% of Group B's respondents (59% < 84%) (See Table 32). This significant difference means that IT staff members at educational institution are more

adaptable to technology change. It can be deduced from data that the legal and compliance issues are the top most challenges in adoption as viewed by IT practitioners at educational institutions whereas IT practitioners working with industry reported end-user's resistance to change as the top most challenge (See Table 32).

Inter-group disagreements also show significant variation between responses. The issues, "Difficulties in Application/Service migration to Cloud Computing" and "No indemnity for service failure by Cloud Vendor" are part of Group A's top five disagreements but they were not part of Group B's top five disagreements. These issues have higher percentage of response in Group A than in Group B i.e. "Difficulties in Application/Service migration to Cloud Computing" (73% of A > 52% of B), "No indemnity for service failure by Cloud Vendor" (55% > 40%, (See Table 33, page 103).

The issues "Increase in IT Dept.'s operational cost" and Lack of QoS or SLA monitoring solutions are part of Group B's top five disagreements but not of Group A's (See Table 33, page 103).

Table 33 Top five Issues disagreed by respondents

Top five Issues/Factors disagreed as a challenge in Cloud Deployment						
	Group A (n = 22)			Group B (n = 25)		
Issues/Factors	**Disagreement**	**%age within group**	**Rank within Group**	**Disagreement**	**%age within group**	**Rank within Group**
Difficulties in Application/Service migration to Cloud Computing	16	73%	**1**			
Difficulty in determining Cloud Vendor's long-term viability or sustainability	15	68%	2	21	84%	**1**
Increase in IT Dept.'s operational cost				15	60%	4
Lack of client's right to audit Cloud Vendors' services or security protocols	14	64%	4	18	72%	3
Lack of QoS or SLA monitoring solutions				15	60%	4
Lack of sufficient migration support from Cloud Vendor	14	64%	3	19	76%	2
No indemnity for service failure by Cloud Vendor	12	55%	5			

4.2.6.2 Impact of migrating IT services on Clouds

This survey asked the respondents to share the impact of migrating IT service on Cloud Computing at their organisation or clients using a closed question. The responses were related to issues identified in the SLR (*Refer to Chapter 3 Section 3.3*). The most selected response was "changed IT/Organisational work patterns" which was selected by 87% of respondents; "forced IT department to invest into staff trainings" was selected by 81% of respondents (See Table 34, page 104). A total of 31 respondents stated that migration of IT Service on Clouds has burdened the IT staff with more work, 18 respondents stated effects of IT service migration as undermining of IT Dept.'s influence and caused IT staff turnover (See Table 34, page 104).

Table 34 Impact of Cloud Computing

Impact of Clouds on client organisations/institutes						
Impact	Group A		Group B		Total	%age response
	n =22	%age response	n =25	%age response		
Changed IT/Organisational work patterns	20	91%	21	84%	41	87%
Forced IT dept. to invest into IT staff trainings	17	77%	21	84%	38	81%
Burdened IT staff with more work	14	64%	17	68%	31	66%
Bred a sense of ineffectualness in IT staff	12	55%	18	72%	30	64%
Undermined IT dept.'s influence	8	36%	10	40%	18	38%
Caused IT staff turnover	3	14%	15	60%	18	38%

**Percentages are rounded off*

These responses confirm that migration of IT Service on Clouds has an impact on all aspects of organisational work including change in the authority of the IT department, changes in IT work, security, compliance, project management, system support and even work of end-users (Yanosky, 2008; Greenwood *et al.*, 2010).

A key challenge reported in SLR was that "change in IT department's role or authority" was mapped to two effects, bred a sense of ineffectualness and undermining of IT department's influence. Similarly, the changes in work pattern burdens staff with more work and loss of internal expertise causes staff turnover and force the organisation to invest in staff training. The response data is transformed by summing the count of responses and then averaging it on the mapped issue, resulted into agreement percentage of IT practitioners on the key challenge issues as a challenge in adoption of Clouds (See Table 35).

Table 35 Adoption issues, their impact on client organisations/institutes

Adoption issues, their impact on client organisations/institutes							
Challenge**	**Impact**	**Group A (n = 22)**		**Group B (n = 25)**		**Agreement**	
		Response Count	**Average Response**	**Response Count**	**Average Response**	**Total (Averages)**	**% of Survey response**
Change in IT Dept.'s role/authority	Bred a sense of ineffectualness in IT staff	12	10	18	14	24	51%
	Undermined IT dept.'s influence	8		10			
Changed IT organisational work pattern	Burdened IT staff with more work	14	17	17	19	36	77%
	Changed IT organisational work patterns	20		21			
Loss of internal expertise (IT Capabilities)	Caused IT staff turnover	3	10	15	18	28	60%
	Forced IT dept. to invest into IT staff trainings	17		21			

**Percentages are rounded off*
***Challenges in adoption of Clouds, refer to Chapter 3 Sec 3.3*

4.2.6.3 Major concerns of the end-users

A question asked the respondent to share the major concerns of the end-users regarding data and services hosted on Cloud Computing. This question was based on the end-user's concerns identified through SLR and helped in validating the SLR's data (Refer to Chapter 3 Section 3.3). The responses were noted using check boxes and a text field was used for other option's details. The major concern of end-user is the "availability of cloud services", reported by 91% of total 47 respondents, followed by "Security concerns or apprehensions" chosen by 42%, "Reliability of services" by 87% and "data privacy concerns" by 66% of respondents (See Figure 13). Lowest percentage of response was of Cloud vendor's vulnerability to Cyber attacks with only 12 of 47 responses (26%) reporting it as a major concern. Respondents reported several other concerns that make about 17% of responses.

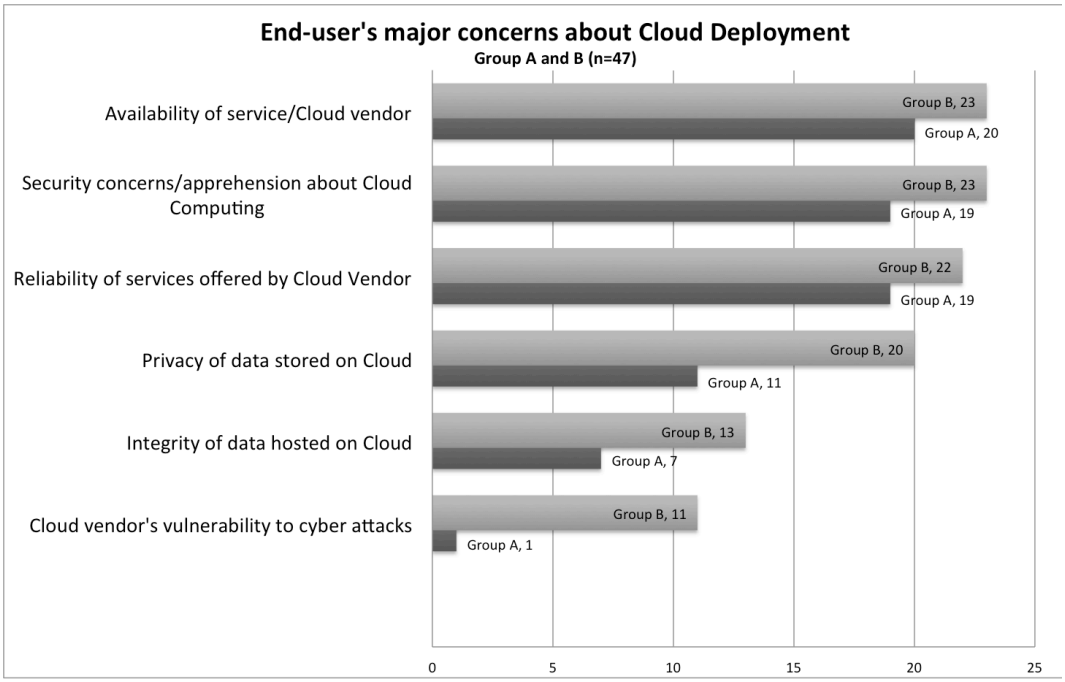

Figure 13 Chart: Major concerns of the end-users about Clouds

Table 36 Major concerns of the end-user about Clouds

Major concerns of the end-users about Clouds						
Group A & B *(n=47)*						
	Group A		**Group B**			
Answer	n = 22	**% age**	n = 25	**% age**	**Total**	**%age**
Availability of service/Cloud vendor	20	91%	23	92%	43	91%
Security concerns/apprehension about Cloud Computing	19	86%	23	92%	42	89%
Reliability of services offered by Cloud Vendor	19	86%	22	88%	41	87%
Privacy of data stored on Cloud	11	50%	20	80%	31	66%
Integrity of data hosted on Cloud	7	32%	13	52%	20	43%
Cloud vendor's vulnerability to cyber attacks	1	5%	11	44%	12	26%
Other: Ofsted/QA record	1	5%			1	2%
Other: Learning new Application/Learning curve etc.	3	14%			3	6%
Other: Change/Resistance to change	2	9%			2	4%
Other: Disruption of current services/ changes in services			1	4%	1	2%

**Percentages are rounded off*

The other concerns reported by Group A are: " Change", "Learning Curve", "Learning how to use the applications for full benefit" "Learning new Applications", "Like old technology, do not want to learn something new" and "Ofsted/QA record" and Group B's other response are "Disruption of current service" and "Disruption of current services/ changes in services".

4.3 Key challenges in adoption of Enterprise Clouds

Challenges in adoption of Enterprise Clouds were initially identified in SLR's resulting in 27 key challenges in adoption of Clouds (Refer to Chapter 3 Sec 3.3, Table 17 p61, Table 18 pg 65, Table 19 pg 71).

The survey's questions help in validate the challenges by IT practitioners' responses. Now after the validation, a new set of the key challenges emerged that would be used in developing the ECAAM model. To reach to a **final list of the key challenges** in the adoption of Enterprise Cloud, the following criterion was applied:

> *"Any issue or concern is agreed by 50% or more than 50% of the IT practitioners then that challenge would be treated as key challenge in adoption of Enterprise Clouds"*

Several studies have used similar criteria to acquire critical or important data Khan, Niazi & Ahmad (2012) identified critical success factors for selection of offshore software outsourcing vendors and used criterion where the factors reported by 50% or more survey participants were critical success factors. Similarly, Hall, Rainer & Baddoo (2002) used this criterion of selecting factor reported by 50% or more respondents as a key factor in Software Process improvement.

By applying the criterion on the issues and concerns agreed by ≥ 50% of responses, the top issues are:

- "End-user resistance to change" reported by 39 respondents out of 47 making it 83% of the total response.
- Legal or Compliance issues in migrating to or accessing Cloud Computing (79%) and "Changed IT organisational work pattern" (77%),
- 24 IT practitioners agreed on the issue of increased dependence on a third party provider as a challenge in the adoption of Clouds (See Table 37).

Table 37 Key Challenges in adoption of Enterprise Clouds

Key Challenges in adoption of Enterprise Clouds					
Group A & B *(n=47)*					
Key Challenge Code	**Issues**	**Agreement**			
		Group A (n = 22)	**Group B (n = 25)**	**Total response**	**%age response**
KC-1	Incompatibility of existing IT Infrastructure/Resources for Cloud Computing	16	16	32	68%
KC-2	Excessive effort is required to re-engineer legacy applications for migration on Clouds	10	15	25	53%
KC-3	Loss of control over IT resources after migration on Clouds	10	15	25	53%
KC-4	End-user resistance to change	17	22	39	83%
KC-5	Changed IT organisational work pattern	17	19	36	77%
KC-6	IT Staff's resistance to change	13	21	34	72%
KC-7	Loss of internal expertise (IT Capabilities)	10	18	28	60%
KC-8	Lack of organisational readiness	8	19	27	57%
KC-9	Change in IT Dept.'s role/authority	10	14	24	51%
KC-10	Increased dependence on a third party provider	9	15	24	51%
KC-11	Legal or Compliance issues in migrating to or accessing Cloud Computing	18	19	37	79%
Key Challenge Code	**Concerns**	**Agreement***			
		Group A (n = 22)	**Group B (n = 25)**	**Total response**	**%age response**
KC-12	Availability of service/Cloud vendor	20	23	43	91%
KC-13	Reliability of services offered by Cloud Vendor	19	22	41	87%
KC-14	Privacy of data stored on Cloud	11	20	31	66%
KC-15	Security concerns/apprehension about Cloud Computing	19	23	42	89%

**Selection of the response is taken as agreement with the issue as a challenge*

Percentages are rounded off

Key issue/concern are agreed by >50% of respondents

Note that data values of concerns in Table 37 were transformed by taking respondent's selection as an agreement. The top two key concerns, stated by IT practitioners are: "Availability of service/Cloud vendor" reported by 43 participants (91% of total sample) and "Security concerns/apprehension about Cloud Computing" reported by 42 participants (89% of sample n=47).

The Likert scale results are nominal in nature and can be used for testing significant difference among groups. The independence of issues and the group responses was measured using chi-square test for independence of variables. The data (agreement count of key issues) was transformed into R x C contingency table and then Chi-square test was applied. Specifically, using Chi-square test is appropriate because the sampling method is random sampling, the data is nominal and the expected frequency count in each cell of the contingency table was at least 5.

The calculated value of test statistic was 4.5812. The critical value of Chi-square $(1-\alpha)$ 0.95 at 10 degree of freedom d.f is 18.307 (The p-Value for this test was 0.917356 thus the result is not significant at $p < 0.05$.). Since the test statistics is lower than the critical value thus the **null hypothesis was accepted that there is independence between the issues agreed upon by Group A and B participants**.

Similarly, chi-square test was applied to concerns, agreed by Group A and B, for that at 3 degree of freedom, and the p-value was 0.767428 and the result was not significant at $p < 0.05$, thus **accepted the null hypothesis of independence of group responses and concerns**. Evidently, IT practitioners from both groups agreed on the issues and concerns as challenge to Cloud adoption with their full understanding and their responses were independent across issues and concerns.

Besides looking at agreement of IT practitioners about the issues and concerns as challenges, the survey's response data set also provides significant issues that were disagreed by the IT practitioners. The disagreement of the practitioners can be taken as rejection of that issue as a barrier in adoption of Clouds. Some of the issues that are rejected by ≥ 50% or more of the IT practitioners are tabulated in Table 38.

Table 38 Issues disagreed by more than 50% of respondents

Issues disagreed by more than 50% of respondents				
Group A & B *(n=47)*				
Issues	**Disagreement**			
	Group A (n = 22)	**Group B (n = 25)**	**Total response**	**%age response**
Difficulty in determining Cloud Vendor's long-term viability or sustainability	15	21	36	77%
Lack of sufficient migration support from Cloud Vendor	14	19	33	70%
Lack of client's right to audit Cloud Vendors' services or security protocols	14	18	32	68%
Difficulties in Application/Service migration to Cloud Computing	16	13	29	62%
Increase in IT Dept.'s operational cost	12	15	27	57%
Lack of QoS or SLA monitoring solutions	11	15	26	55%
Vendor /Service lock-in issues	11	13	24	51%

**Percentages are rounded off*

The major end-users concerns were collected using check boxes which gives counts or numerical values, thus the selection by one survey participant can be treated as his/her agreement to the concern as an adoption challenge but not vice versa (not-selecting a concern from the list cannot be treated as disagreement by the IT practitioners). The end-user concerns selected by less than 50% of the survey participants are "Cloud vendor's vulnerability to cyber attacks" and "Integrity of data hosted on Cloud". 12 participants selected the concern "Cloud vendor's vulnerability to cyber attacks", which is about 26% of total response, whereas "Integrity of data hosted on Clouds" was selected by 43% of participants, thus both have not been selected by more than 50% of the survey participants (Refer to Table 36 page 106).

4.3.1 Comparison: Survey results with SLR results

A comparative analysis of key challenges identified through SLR and Survey is presented in this section. This would help the reader to visualise similarities and differences among the outcomes of the two data sets.

Table 39 (page 113) presents a summary of all the challenges identified through SLR and questionnaire survey. The SLR data has not been modified by using any categorisation, however the survey response represent categorical values of Strongly Agree, Agree, Neutral, Strongly Disagree, Disagree and Not Sure/Neutral. To compare these two datasets, the challenges from the survey results show the agreement percentage, which is a summation of Strongly Agree and Agreement values, and Selection values treated as agreement from responses (See Table 31 on page 99; Table 35 on page 105; Table 36 on page 106)

The survey included open-ended questions to gain tacit knowledge about challenges in adoption of Clouds from survey participants and gain other challenges besides the one reported in SLR literature. Furthermore, no new challenge was added to the data set through Survey or reduced due to zero frequency response hence the count of challenges remain the same (27 identified through SLR and 27 challenges reported in survey response.

Note in data in the Table 39, the highest percentage values are given lowest ranks. While assigning the ranks, if any two challenges share the same value, an average rank is given to both. The next challenge is adjusted appropriately by assigning next rank. For example, in Table 39, both "Privacy of data stored on Cloud" and "Vendor /Service lock-in issues" have a value of 0.36 (or 36%), they both share the rank value 5 and 6, whereas an average rank value of 4.5 is assigned to both challenges. This mechanism is used in ranking all ties of the percentage values of occurrence of the challenge in SLR's results set and agreement by IT practitioners' survey response.

It can be seen in tabulation that the challenges from both data sets vary in ranking. The challenges ranked high in SLR are not necessarily ranked high in Survey i.e. "Vendor/Service lock-in issues" in top 5 challenges reported in SLR (with rank value of 4.5) but in Survey this challenge is ranked at 19th position based on agreement by the IT practitioners. These variations suggest that

there is a disagreement between the results of the SLR and the results of the Survey in terms of relative importance of the adoption challenges in the adoption of Clouds.

These variations in rank across the data sources called for testing the strength of correlation of both variables (SLR's occurrence and IT Practitioners' agreement). Spearman's Rank Order Correlation was applied on the challenges obtained from the SLR and the Survey. **The value of Spearman's rank correlation coefficient is 0.25, which suggests that that the two sets of data show weak, positive correlation between them, but this correlation is not statistically significant. This conclusion of insignificance of correlation is reached by using the test statistic p(25)= 0.25 and the p was found to be 0.20739 thus result is not significant at p < 0.05.**

Table 39 Challenges in adoption of Enterprise Cloud Computing

Challenges in adoption of Enterprise Cloud Computing								
		Occurrence in SLR results (n= 25)			Agreement in Survey response (n= 47)			
Sr.	Challenges (issues and concerns)	Frequency	Reported in % of papers	Rank	Agreement	% Agreement survey	Rank	Average Rank
1	Security concerns/apprehension about Cloud Computing	15	60%	1	42	89%	2	2
2	Reliability of services offered by Cloud Vendor	13	52%	2	41	87%	3	3.5
3	Legal or Compliance issues in migrating to or accessing Cloud Computing	11	44%	3	37	79%	5	5.5
4	Availability of service/Cloud vendor	7	28%	6	43	91%	1	6.5
5	Privacy of data stored on Cloud	9	36%	4.5	31	66%	9	9
6	Vendor /Service lock-in issues	9	36%	4.5	12	26%	19	14
7	Lack of interoperability between Cloud service or Cloud Vendors	7	28%	8	21	45%	16	16
8	Change in IT Dept.'s role/authority	5	20%	10.5	24	51%	14.5	17.75
9	Increased dependence on a third party provider	5	20%	10.5	24	51%	14.5	17.75
10	Difficulties in Application/Service migration to Cloud Computing	7	28%	7	9	19%	22.5	18.25
11	Integrity of data hosted on Cloud	5	20%	10.5	20	43%	17	19
12	Incompatibility of existing IT Infrastructure/Resources for Cloud Computing	4	16%	15.5	32	68%	8	19.5
13	Loss of control over IT resources after migration on Clouds	4	16%	15.5	25	53%	12.5	21.75
14	Difficulty in determining Cloud Vendor's long-term viability or sustainability	5	20%	10.5	6	13%	25	23
15	End-user resistance to change	3	12%	23	39	83%	4	25
16	Cloud vendor's vulnerability to cyber attacks	4	16%	15.5	12	26%	19	25

Challenges in adoption of Enterprise Cloud Computing								
		Occurrence in SLR results (n= 25)			Agreement in Survey response (n= 47)			
Sr.	Challenges (issues and concerns)	Frequency	Reported in % of papers	Rank	Agreement	% Agreement survey	Rank	Average Rank
17	Decrease in service performance after migrating services on Cloud Computing	4	16%	15.5	12	26%	19	25
18	Changed IT organisational work patterns	3	12%	23	36	77%	6	26
19	No indemnity for service failure by Cloud Vendor	4	16%	15.5	11	23%	21	26
20	IT Staff's resistance to change	3	12%	23	34	72%	7	26.5
21	Loss of internal expertise (IT Capabilities)	3	12%	23	28	60%	10	28
22	Lack of organisational readiness	3	12%	23	27	57%	11	28.5
23	Increase in IT Dept.'s operational cost	4	16%	15.5	5	11%	26	28.5
24	Excessive effort is required to re-engineer legacy applications for migration on Clouds	3	12%	23	25	53%	12.5	29.25
25	Lack of sufficient migration support from Cloud Vendor	3	12%	23	9	19%	22.5	34.25
26	Lack of QoS or SLA monitoring solutions	3	12%	23	8	17%	24	35
27	Lack of client's right to audit Cloud Vendors' services or security protocols	3	12%	23	4	9%	27	36.5

Percentages are rounded off, Data is sorted on Average rank in ascending order

Total number of papers in SLR result 25

Total survey response is 47 responses

Lowest percentage has highest rank, ties are given average rank, The ranking is of the percentages of occurrence and agreement responses

Further analysis on this data set was carried out to see the variation in the relative importance of the challenges discussed in Section 4.3.2 and 4.3.3.

4.3.2 Challenges relatively important in SLR's results

There are five challenges that were relatively important in SLR's results but not in Survey responses. Based on survey's data, it is argued that IT practitioners do not agree with these five factors (higher in SLR's results) as relatively significant challenges in adoption. However, the conclusion does not imply rejection, rather in practitioners' view these are not as important as other challenges. The challenges are:

- "Vendor /Service lock-in issues" has occurred in 36% of SLR's results but on other hand it is only agreed by 26% of IT practitioners.
- "Difficulties in Application/Service migration to Cloud Computing" was at 28% on SLR's results being relatively important yet it is agreed by only 19% of survey participants as a challenge. The issues of "difficulties in application/service migration to Cloud Computing" could be insignificant or disregarded by the IT community due to multiple factors but one plausible explanation can be that over a passage of time the Cloud technology has improved, making it less difficult to migrate existing services on Clouds. Analysing the data set of the SLR and the challenge "difficulties in application/service migration to Cloud Computing" it is seen that the year of publication for the papers, that are the source of the quote, range from 2009 to year 2011. The survey data was collected in early year 2014, which implies that in three years the Cloud technology has improved making migration of data or service easier, thus in IT practitioners' perception this is not a significant barrier to adoption of Clouds in Enterprise.
- "Difficulty in determining Cloud Vendor's long-term viability or sustainability" – 20% in SLR's results but 13% in survey. Again, I would like to argue that this issue is perhaps resolved as now Vendor's long term viability may be a factor in decision making or selection of Vendor but to say that it is creating hurdles in adoption of Clouds is not appropriate because of the availability of cross-platform APIs, middle-ware, Cloud Management services and Data Migration

services. These new APIs/Middleware help in migrating data, if a Cloud vendor goes out of business, the disruption can be kept at minimal by migrating to other Clouds. Using middleware or open source APIs also counters the vendor lock-in issues.

- "Increase in IT department's operational cost" – 16% in SLR's results but 11% of survey respondents agreed to it.
- "Lack of client's right to audit Cloud Vendors' services or security protocols" was at 12% in SLR's results whereby only 9% of the survey participants agreed to consider it as a challenge in adoption. Arguing on similar line, in year 2009 Clouds were relatively new as an Industry and lacked laws governing it. Now Cloud industry itself leads initiatives to offer their Compliance/Security certifications to prospective clients. Cloud Security Alliance (CSA) offers registry of Cloud vendor and their compliance certifications.

4.3.3 Challenges relatively less important in SLR's results

Four challenges with relatively low occurrences in SLR's results yet highly agreed by IT practitioners' as challenges in the adoption of Clouds are:

- "End-user's resistance to change" has occurred in 12% of the SLR's results whereas 83% of the survey respondents have agreed with it as an issue that challenges Clouds deployment.
- "Changed IT organisational work patterns" is reported in 12% of SLR results and agreed by 77% of the IT practitioners.
- "IT Staff's resistance to change" is reported in 12% of SLR results, whereas 72% have agreed with it.
- "Loss of internal expertise (IT Capabilities)" is reported by 12% in SLR's papers whereas 60% of survey respondents agreed with it.

While analysing the data sources of the quotes, it is noted that all four challenges are reports in three papers which are Paper09 (Khajeh-Hosseini *et al.*, 2010), Paper19 (Khajeh-Hosseini, Greenwood & Sommerville, 2010) and Paper24 (Sultan, 2010).

Cloud Adoption Toolkit (CAT) is a pioneering work that presents a decision toolkit to support decision of an Enterprise to migrate to IT services on Clouds (Khajeh-Hosseini *et al.*, 2010; Khajeh-Hosseini, Greenwood & Sommerville, 2010; Khajeh-Hosseini *et al.*, 2011; Khajeh-Hosseini *et al.*, 2012). The two case-studies (Khajeh-Hosseini *et al.*, 2011; Khajeh-Hosseini *et al.*, 2012) are based on experiences of applying CAT in Enterprise settings. These challenges were reported as outcomes of CAT's module on stakeholder analysis. The issue identified through CAT were ground breaking in nature at that point of time (year 2009-10), hence reported less in literature. Now these issues stand validated by IT practitioners' perception that in an Enterprise the issues of End-users' resistance to change, IT staff's change and change in work patterns are barrier to adoption of Enterprise Clouds.

4.4 Industrial Practices

One objective of this survey was to explore the practice, strategies that helped the Cloud experts in overcoming the challenges in adoption of Clouds. This data helped in answering the second research question (Refer to Chapter 1 Section 1.2 **RQ2**). The terms "practice" or "practices" represent the industrial practices, best practices or industry-preferred practice. Survey questionnaire had several questions where the central theme was to ask the IT Practitioners about their practices in overcoming the challenges, effectiveness of practices in their experience and suggestions addressing end-user concerns.

A mix of open-ended and close-ended questions were added to the survey to explore the practices, techniques and methods that can help an Enterprise in addressing the challenges in the adoption of Enterprise Clouds (**RQ2**).

The open-ended questions focused on codifying the tacit knowledge about the applied techniques or actions or their experience on applicability of the practices in overcoming the issues or concerns. One caveat of using open-ended questions is that respondents tend to ignore them (Kelley *et al.*, 2003). This phenomenon was observed in this data set as only a few keen respondents have answered the questions by typing their views. These few enthusiastic people helped the most in developing an understanding about the industry and its practices.

An initial list of practices was developed from literature on technology adoption, Clouds adoption, SLR's results and commercial white papers. Several practices were picked from discussions with leading Cloud evangelists, Keele's University IT staff members, general IT literature, industrial visits and conference discussions.

The following sections presents the questions asked in questionnaire about practices and the responses given by the respondents.

4.4.1 Practices/Strategies to overcome adoption challenges

A question in survey asked the participants to suggest strategies or practices that they think would overcome the issues in a short span of time. An issues list was presented with text box for recording the response against each issue. This optional question was open-ended and was

presented to the survey participant immediately after the question that sought their agreement of issues as challenges in adoption of Clouds. A total of 11 issues (from a list of 18 issues) had 21 suggestions provided by the participants. The responses were gives by a total of 6 participants (Group A – 1, Group B – 5) that is 13% of total respondents.

Note that in Table 40 (page 123), issues, suggested strategy/practices and respondent profile are tabulated so that the reader can visualize the respondents background that would help in better understanding of the context of the response. Further discussion on the responses is presented with respondent profile, and the issues and the suggestions given by the respondents.

Respondent05 is working as Head of Computing and IT at a Higher Educational Institution with over five years of experience in current job/role. He has given suggestions to overcome the issue of "lack of organisational readiness". He mentions this fact that the institution adopted Cloud services in 2007 and it has taken a long time for people to fully realise the benefits and "the process is still underway". He has also suggested that the motivation and benefits that are to be realised from migrating to Clouds should be shared with staff. Implicitly, he suggests that the transition plan of adopting Clouds with "small steps" should be shared amongst stakeholders.

To overcome the issue of "lack of QoS or SLA monitoring solutions", Respondent02 (IT Manager, 1-3 years experience) suggested that focus must be on selection of (correct) vendor and review of SLA. Service Level Agreements are the foundation of client–vendor relationship. The decision makers must read between the lines and involve legal experts (Khajeh-Hosseini *et al.*, 2011), as SLAs notoriously contain legal jargon. Several industrial forums and governmental agencies (Cloud Industry forum UK, UCISA, ENISA EU, US Federal Government IT Services etc.) have either published guidelines to develop SLAs for Cloud services or have a standard SLA template. It is a good practice to follow the peer companies and observe their approach towards SLAs.

To overcome the Legal issues and issues with Clouds' compliance, Respondent10 (Business Analyst, 3- 5 years of experience) suggested having detailed discussions on compliance issues during the sales process and heavy involvement of legal teams. Discussions on Cloud's compliance during the sale/acquisition process help in making informed decision about Cloud vendor and build stakeholder's awareness on legal ramifications of adopting Clouds. A similar view was expressed in

literature that right questions should be asked from Cloud service provider (vendor) about their compliance with applicable laws and regulations (Heinle & Strebel, 2010). However, this requires IT Manager (or decision makers) to have awareness of applicable laws and regulations. Organisational legal department should be engaged during decision-making, vendor selection, drafting of SLAs and acquisition of Clouds services.

Cloud computing, like other vendor-provided services, considers interoperability as a desirable factor that help avoid the vendor lock-in. Respondent02 advises the use of Cloud middleware and APIs. Vendors do provide their own APIs to their clients i.e. Amazon Web Services (AWS) API and Eucalyptus, Google Compute Engine etc., but there are several cross-platform APIs available that work with multiple Cloud vendors. These cross-platform APIs are either open-source (Apache Foundation) or commercial services (SimpleCloud) i.e. VMware vCloud API, SimpleCloud API, OpenStack API etc. Apache CloudStack supports other APIs including AWS API, OpenStack API, VMware vCloud API and can help IT Managers to deploy either Hybrid or Private Cloud model in their organisation (Apache Software Foundation, 2015). Respondent09 (Systems Administrator, ≥ 5 years experience, works at University) endorses the use of open source standards and APIs to avoid vendor lock-in issues (See Table 40, page 123).

Respondent21 (IT Consultant, 3-5 years of experience) suggests using a Cloud vendor that offers “generic” HTTP and HTTPS APIs. Google Compute Engine (Google Inc, 2016) is an IaaS Cloud service that offers instances of virtual machines and support clients of multiple programming languages (Java, Python) and libraries (Apache libcloud). Apache libClouds supports access to Google Cloud Engine over simple http and https request, paving way for more client control over purchased resources (Yegulalp, 2014).

Decrease in service performance after migrating services on Cloud Computing is reported in SLR as an issue; agreed by 19% of survey participants as a challenge in adoption of Clouds. Respondent02 recommends that performance variables should be noted and benchmarks must be set before and after the adoption of Clouds. This would form a comparative baseline of quality of services and any noticeable decrease in service performance would be monitored. Vendor could be approached with decreased performance values to get rectification for the poor quality of service

issues. On the same issues, Respondent9 advises caution about ignoring IT staff while migrating IT services on Clouds as the decreased performance could be due to the incompatibility of the existing systems managed by them. This implies that opinion of current IT staff should be not be ignored and they must be involved in the adoption/acquisition process.

To overcome the difficulties in migration of applications and services to Clouds, Respondent02 suggested that there are several commercial migration tools available for data or service migration. Some of the well-established Cloud vendors provide their own tools or client can also use other services/tools for migration for example IBM WasDev, Microsoft Assessment and Planning toolkit for Azure CloudMigrator Gmail migration, Egnyte Storage Sync, etc. Besides using standard tool, if there is a need then a customised data migration tool could be developed, though its development cost would increase the cost of Cloud migration process. Respondent21 suggests that vendor partner should be involved as they can provide vital support at this point. This view is also advocated by Respondent10 as he states that Vendor's implementation partner can provide support and help in overcoming challenges associated with application migration. He claims that his organisation "apply the best practices and expert knowledge of migrating from multiple platforms" to address issues of service/application migration on Clouds.

Janssen & Joha (2011) reported a worrisome perspective that IT Managers felt that migration of IT services on Clouds increases organisational dependence on third party service providers. Respondent09 suggests keeping a back-sourcing plan ready (See Table 40, page 123). Back-sourcing is to bring IT functions back in-house after they have been outsourced to a service provider, but this action usually have contract penalties. Outsourcing research (Iden & Langeland, 2011) suggests that back-sourcing plan and its execution in case of service provider's failure would ensure business continuity. Perhaps ensuring that a plan is in place gives IT Managers some comfort.

On the question about lack of organisational readiness, Respondent17 (IT Consultant, 1 to 3 years of experience) suggests that change in management and training programme would prepare an organisation for the adoption of new technology. This view is also reinforced by information provided by Resondent09 who suggests that the Business transformation team (assumedly he is a

part of it) identifies workflows affected by technology change and addresses them, while supporting the end-user during the entire deployment project.

And in the last, it is not a practice rather an advice from Respondent9 that the Clouds' capacity should exceed the existing capacity so as to cater for future growth (See Table 40, page 123).

Evidently, what we take from these suggested practices:

- Must involve Legal team in vendor selection process/service acquisition process
- Have detailed discussions on compliance issues during Vendor selection/ Service acquisition process
- Develop a vision statement (or document) about the Clouds benefits and communicate it with your staff
- Make a transition plan of adopting Clouds with "small steps" and communicate it amongst stakeholders
- Current IT staff should be involved and must be valued in decision making process
- Prefer using open-source APIs and Vendor's to access Clouds services or store data
- Use reseller/Vendor partners for Application/Service migration support
- Identify the workflows/processes that will be changed and transform them first.

Table 40 Strategies/practices to overcome the adoption challenges

Strategies/practices to overcome the challenges					
Group A and B *(n=47)*					
Respondent's Profile				**Overcoming the Issues: Suggested practices**	
Respondent ID	**Group**	**Job title/ Role**	**Years in Job/Role**	**Suggested strategies/practices**	**Issues**
Respondent05	A	Head of Computing and IT	Over 5 years	"We adopted Cloud Services very early (2007 Google Apps for Education) it has taken a very long time to help people see the full benefits...that process is still underway!"	Lack of organisational readiness
Respondent02	B	IT Manager	1 to 3 years	"Select the correct vendor and review SLAs"	Lack of QoS or SLA monitoring solutions
Respondent10	B	Business Analyst	3 to 5 years	"Discussion that happens during the Sales process."	Compliance issues in migrating to Clouds
Respondent10	B	Business Analyst	3 to 5 years	"Legal teams do get involved heavily in the Sales process."	Legal issues in accessing Cloud Computing
Respondent21	B	IT Consultant	3 to 5 years	"Choose a vendor who provides indemnity"	No indemnity for service failure by Cloud vendor
Respondent02	B	IT Manager	1 to 3 years	"Middleware or API integration"	Lack of interoperability between Cloud services or Cloud vendors
Respondent21	B	IT Consultant	3 to 5 years	"Cloud is relatively new so these things will come with tie and demand"	
Respondent09	A	Systems Administrator	Over 5 years	"Specify open standards and include migration in _and_ out as part of the spec"	Vendor /Service lock-in issues
Respondent21	B	IT Consultant	3 to 5 years	Select a vendor with generic HTTP and HTTPS API, that helps	
Respondent02	B	IT Manager	1 to 3 years	"Set benchmarks and monitor performance before and after"	Decrease in service performance after migrating services on Cloud Computing
Respondent09	A	Systems Administra	Over 5	"Don't ignore IT staff who have carefully specced	

Strategies/practices to overcome the challenges					
Group A and B *(n=47)*					
Respondent's Profile				Overcoming the Issues: Suggested practices	
Respondent ID	**Group**	**Job title/ Role**	**Years in Job/Role**	**Suggested strategies/practices**	**Issues**
		tor	years	existing systems"	
Respondent02	B	IT Manager	1 to 3 years	Standard migration tools and custom data migration	Difficulties in Application/Service migration to Cloud Computing
Respondent10	B	Business Analyst	3 to 5 years	"Our team of implementation specialists apply best practices and expert knowledge of migrating from multiple platforms"	
Respondent21	B	IT Consultant	3 to 5 years	"Use a partner who can deal with these issues"	
Respondent09	A	Systems Administrator	over 5 years	"Have a back sourcing plan ready"	Increased dependence on a third party provider
Respondent02	B	IT Manager	1 to 3 years	"Find a reseller partner"	Lack of sufficient migration support from Cloud vendor
Respondent21	B	IT Consultant	3 to 5 years	"Choose a vendor that does provide support"	
Respondent10	B	Business Analyst	3 to 5 years	"Our Business Transformation team has detailed knowledge, experience, and established best practices to support users and business units prior to, during and after the deployment. We identify work flows and specific change impacts to address."	Lack of organisational readiness
Respondent17	B	IT Consultant	1 to 3 years	"Change management and training programs"	

4.4.2 Training

Training the end-users on the new technology is an important aspect in the introduction of technology. Survey asked the participants "Which of the following trainings were provisioned for or provided to end-users?". The most frequent response was "Online material/Intranet website" selected by 68% of respondents, followed by Hands-on training sessions – 53%, (distribution of) Cheat Sheets/Hand-outs – 23%, Peers sharing their experience – 15% and other types of training were reported by 11% of total 47 respondents (See Table 41).

Table 41 Training provided to End-users

Training provided to End-users						
Group A and B *(n=47)*						
Training	**Group A (n = 22)**	**% of Group A**	**Group B (n = 25)**	**% of Group B**	**Total Response**	**%age response survey**
Online material/Intranet website	13	59%	19	76%	32	68%
Hands-on training sessions	10	45%	15	60%	25	53%
Cheat sheets/hand-outs	4	18%	7	28%	11	23%
Peer experience sharing	2	9%	5	20%	7	15%
Others: Trained student to drive change	1	5%			1	2%
Others: Peers Training	1	5%			1	2%
Others: Online training course/videos	1	5%	1	4%	2	4%
Others: Introductory seminar/talks			1	4%	1	2%

Sorted by highest response in descending order
Percentages are rounded off

IT practitioners from Group A report other types of training given to end-users were "trained students to drive change", "Peer training" and "Online video/training course", moreover one participant mentioned that the online training course was forced on all end-users. The practice of forcing all end-users to learn new technology may not be a new idea (using coercion in job is not unheard off), but its effectiveness on improving technology adoption needs to be further explored through research.

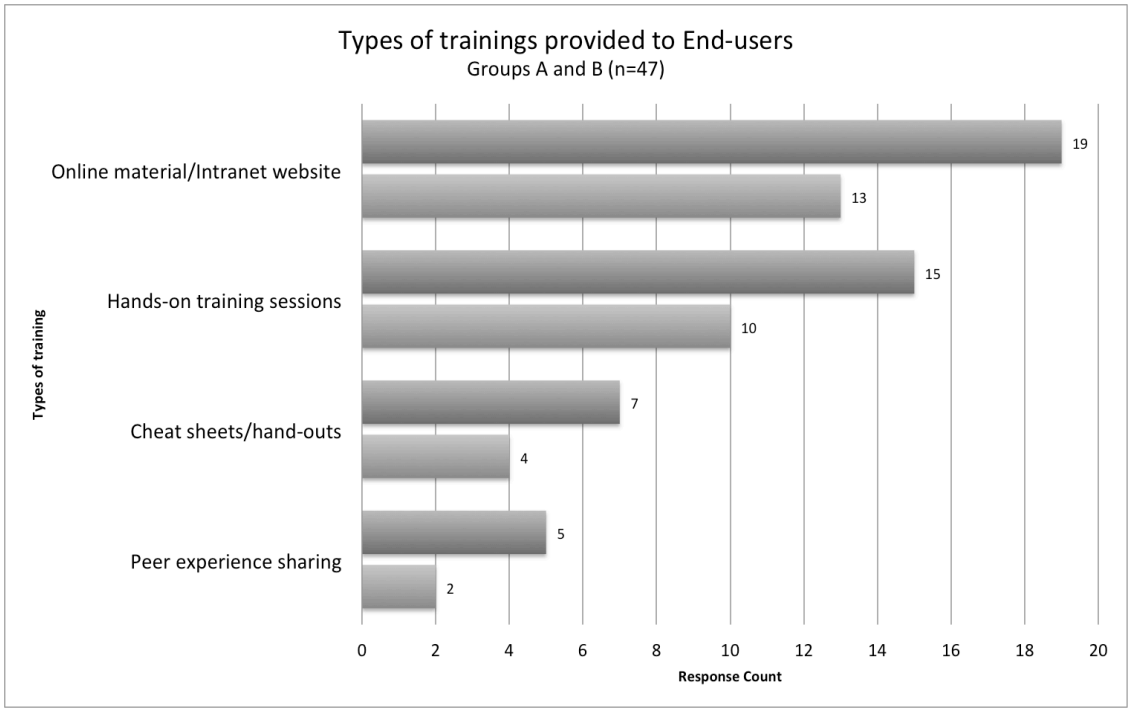

Figure 14 Chart: Types of training provided to End-users

This data shows us that multiple types of training were given to end user to help them to assimilate the Cloud technology and thus creating a facilitating environment for Cloud technology adoption. Marshall, Mills & Olsen (2008) reported that End user training is an important aspect of technology adoption; it improves performance of the employees and aids the acceptance of the new technology in organisations.

4.4.3 Addressing End-users' concerns

The SLR results have shown that one of the major challenges in adoption of Clouds in an Enterprise is the concern of the end-users, from security to availability of Clouds services etc. The survey asked the respondents to share their practices/actions that helped in addressing end-users' concerns or changing their perception about Clouds. The question was open-ended and a text box was provided for responses. The response are rephrased and presented here with respondents details:

- Respondent05 (Head Computing and IT, over five years of experience) reports that every person must see how using the Clouds benefits him or her. The purpose is to self-reflect on the benefits of adoption of Clouds resulting in

increased productivity, enhanced interaction with students or parents and work mobility.

- Respondent10 reports that identification of workflows help to develop customised training to educate end-users. This enables end-user to start working on the newly deployed Cloud services with minimal disruption of work.
- Respondent13 (IT Manager, 3-5 years experience) reports that educating the end-users and change management initiatives help in addressing the end-users' concerns.
- Respondent18 (CEO, over 5 years of experience) advocated developing communication program to communicate staff about the new technology.
- Respondent80 (IT Consultant, 3-5 years of experience) advocates Training and Communication plans as helpful practices.
- Respondent4 (IT support, 1-3 years of experience) states that training, open meetings, communication plans and 1-2-1 coaching helps in addressing end-users concerns about migrating to Clouds or newly deployed Cloud services.

The responses to this question show that educating end-users through training is an effective approach to address end-user concerns about Cloud technology. Evidently, the consensus is on two practices to address end-user-concerns:

- End-user training
- Communication plans

Knight (2015) believes that one single format or style of training should not be offered to employees because every employee has a different level of familiarity with digital technology and Internet. She recommends first asking the staff that what kind of training they are "more comfortable with" or want and then developing customised training including instructor led training to "handholding" or "personal coaching" (Knight, 2015). Large companies often struggle in adopting

emerging technologies due to unwillingness of senior executives, Kaplan & Norton (2006) recommend that senior executives should be trained first and later disseminate it to others.

Communication plans are part of communication program to educate the end-users about the new organisational decision or initiatives of adoption of new technology. In simple terms, the communication plan is a document that lays down the plan for the communication program. It defines the information being shared with the audience and resource person who is sharing using which medium. In deployment of any new technology sharing accurate information helps in addressing fears and overcoming the technology adoption resistance which occurs due to inadequate or inaccurate information (Kotter & Schlesinger, 2008).

Another question asked about the effectiveness of approaches in overcoming the end-users' concerns was to rate the approaches by selecting effective, ineffective, never applied and no answer. No answer and Never applied were treated as invalid answer and effective and ineffective were taken as valid answers.

Table 42 Practices to address the users' concerns

Practices & their effect in addressing users' concerns								
Group A and B *(n=47)*								
	Valid							
	Effective				**Ineffective**			
	Group A		**Group B**		**Group A**		**Group B**	
Practices	Count	**%age**	Count	**%age**	Count	**%age**	Count	**%age**
Change Champion Initiatives	10	45%	16	64%	1	5%	2	8%
Dissemination Seminars	5	23%	7	28%	3	14%	10	40%
Informal Staff Meetings	13	59%	15	60%	1	5%	0	0%
Newsletters & Internal Branding	14	64%	13	52%	0	0%	0	0%

Percentages are rounded off

Note that in Table 42 count of valid and invalid responses are given, however only valid responses are discussed here. The valid responses about applying the approach and finding it effective or ineffective in overcoming the end-user's concerns are:

- The most effective approach applied by practitioners to address the end-users' concerns is conducting informal meetings with end-users to know their concerns. Informal meetings are not time restricted and can happen at any informal place

(like water dispenser chats, lunch or coffee breaks) by IT Managers or Project leaders with end-users, preferably variety of end-users. Thirteen (13) respondents from Group A – 59% and 60% of Group B's respondents found informal meeting as an effective approach to address end-users' apprehensions.

- Using internal newsletters and internal branding to share the details of new technology and answer the FAQ or address the concerns by providing information help in getting the message across end-users. Group A's 64% respondents and Group B's 52% find this approach effective. Most of the Enterprises' (even educational institutes/Universities) communication or marketing department handling newsletter and internal branding make this a participatory activity thus increasing its effectiveness.

- Change Champion Initiatives is to have a senior executive as a leader or change champion and act as the face of the new change, by talking to employees, showing them how he/she uses the new technology in their work. Ten respondents of Group A (10 of 22) – 45% reported that they have found this approach effective while a higher percentage – 64% of Group B's respondents found it effective to address end-users' concerns.

- Dissemination Seminars talk about the newly adopted technology by conducting seminars. Twenty-three percent (23%) of Group A's respondent and 28% of Group B's respondents find it effective, whereas about 14% and 40% of respondents in both group A and group B respectively find it as an ineffective approach. Perhaps the formal nature of the seminar makes the dissemination seminars ineffective in addressing the end-users' concerns.

4.4.4 Assessments and Actions carried out before deployment of Clouds.

An IT Manager or Project leader tend to carry out assessments of service and process before adopting any new technology. A question in survey asked, "Which of the following actions (or similar in nature) were carried out before migrating/deploying or launching the IT services hosted on Clouds?"

The responses comprised following options:

- Assessed organisational-wide change impact
- Assessed End-users change impact
- Assessed IT Team Change impact
- Assessed new IT resource needs
- Assessed data sensitivity & criticality of work
- Assessed IT staffing and training needs

Most of the survey participants – 57% (27 of 47) selected "Assessment of IT staffing and training need" as assessment carried out before deployment, followed by assessment of criticality of data & work – 47%, assessment for new IT resource needs – 32%, assessment of change impact on IT team – 15%, assessment of change impact on end-users'– 13% and only 9% respondents assessed change impact at organisational level (See Figure 15).

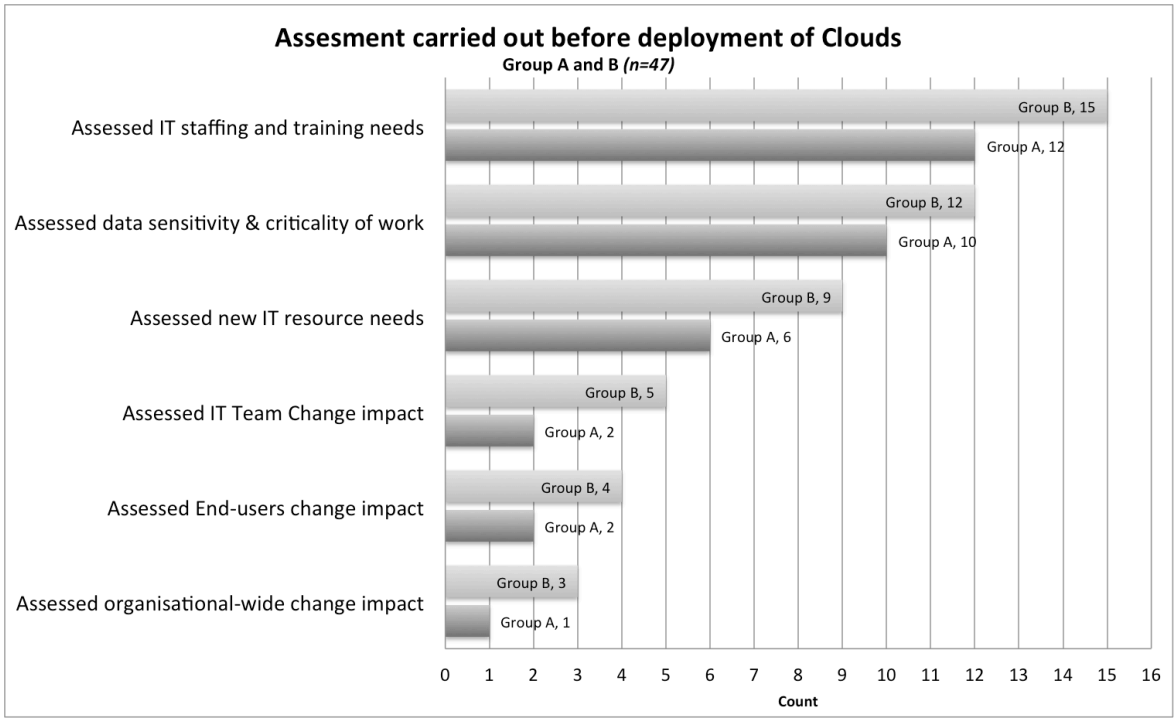

Figure 15 Chart: Assessment carried out before deployment of Clouds

Furthermore, other actions taken before deployment of Clouds are: “Planned and executed Pilot Testing Project” selected by 79% (37 of 47) of respondents, “Sought senior executive's support as change champion” – 53%, “Developed end-users training plans” – 49%, “developed internal marketing plan for Clouds” – 30%, “profiled users' service needs and usage patterns” - 19%, “developed Systems transition plan” – 17% and only 15% selected “developed existing software/hardware integration plan” (See Figure 16).

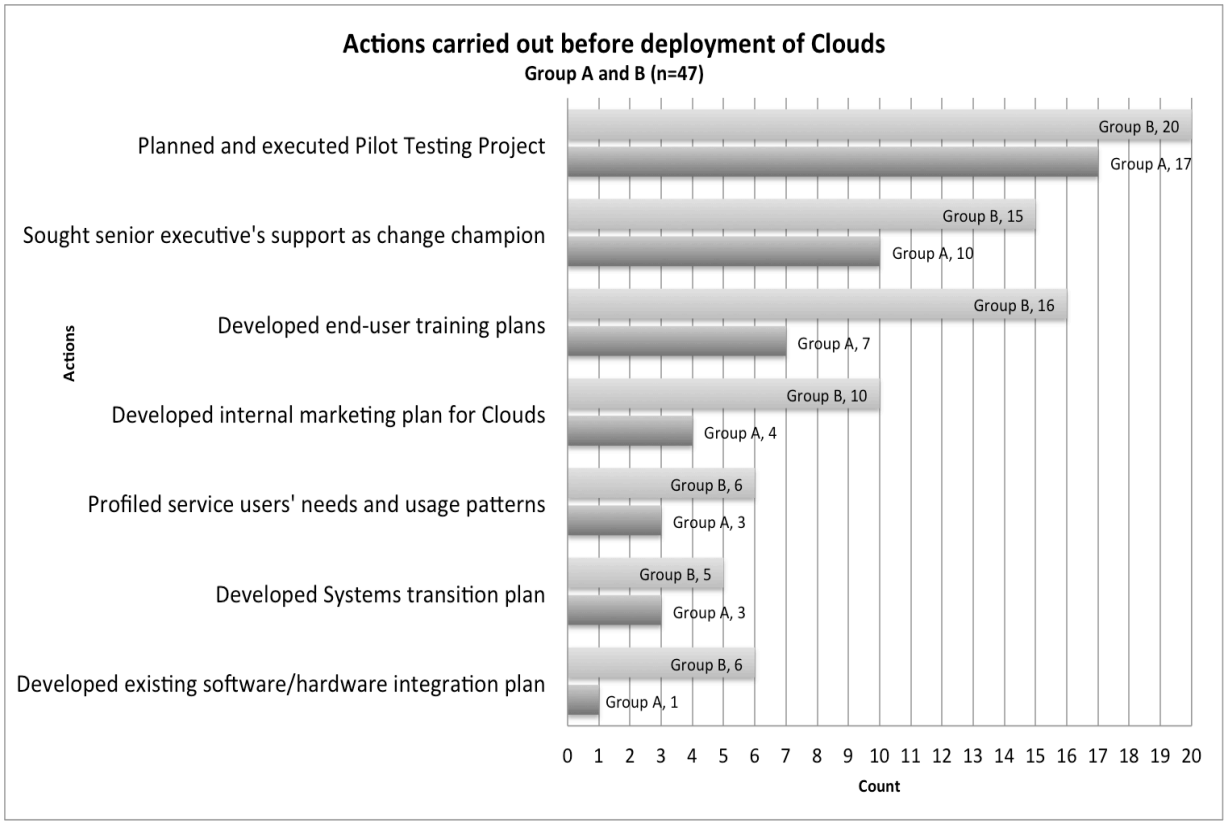

Figure 16 Chart: Actions carried out before deployment of Clouds

4.4.5 Actions carried out after deployment of Clouds.

Highest number of survey participants from both groups selected the response "updated IT services catalogue" when asked about the practices/actions carried out after the roll-out of the migrated/deployed Cloud hosted service. This was followed by the response they took action to measure usage/uptake of hosted services (60%), 34% launched training for IT staff and removed old desktop based application (MS Office) and 30% stated that they removed it for specific user groups (See Figure 17)

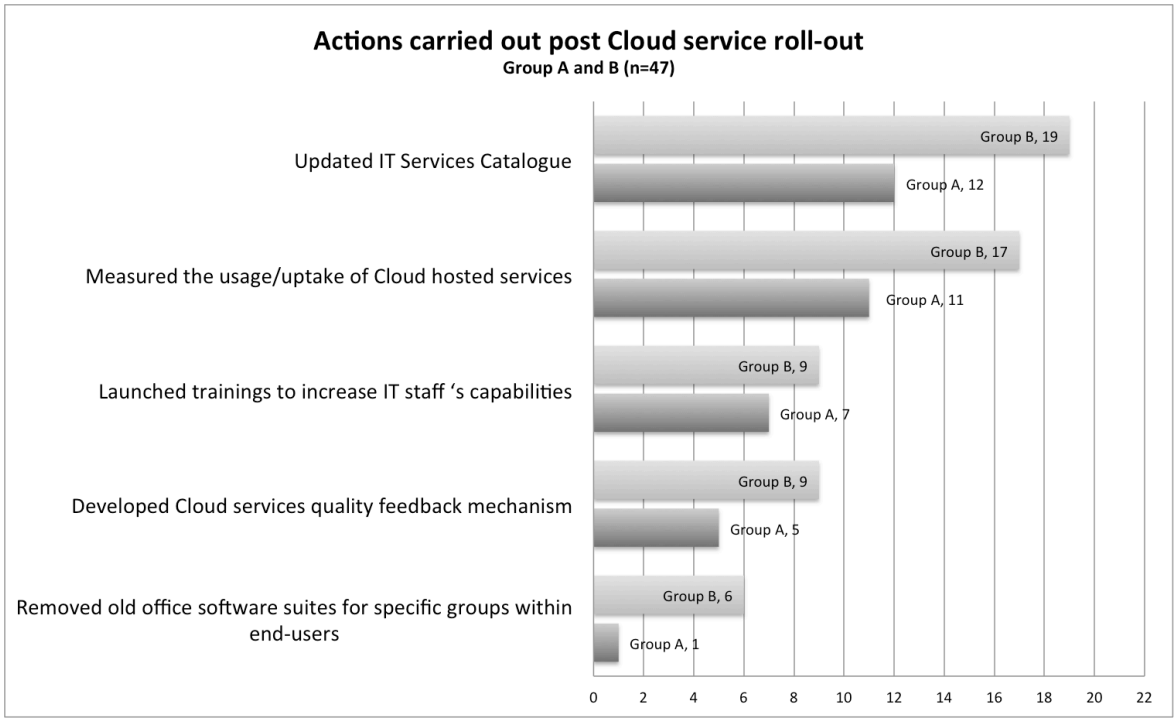

Figure 17 Chart: Action carried out post Clouds service rollout.

4.4.6 Promising Practices: Effectiveness of any particular practice

A question about the effectiveness of any particular practice applied by the IT practitioners during the deployment of Enterprise Cloud Computing is raised here. Although, the set of reported actions and practices in the survey response are based on the experiences of the IT practitioners, still can they can overcome the challenge in other organisations, in real world or industrial settings. Answer to this question is available in evidence based clinical practise, where Doctors are taught to seek new interventions/practices to overcome diseases from state of the art of research but question the strength of the available evidence. Evidence-based practice is an interdisciplinary approach applied in clinical practice, where the basic principles are "extensive appraisal of the available research evidence on effectiveness of potential treatment", "application of expertise (judgment and experience) to identify risks and benefits of the potential treatment on individual patient" and "patient's preferences and values" (Wolf, Dulmus & Maguin, 2012).

Learning from Evidence-based practices in medicine, all available practices/interventions are classified on the basis of creation: the strength of the evidence for proven effectiveness. The U.S. Department of Health and Human Services defines three levels of practices based on the evidence of its effectiveness, and assigns the highest degree of proven effectiveness to "research

validated practices", second to "field tested practices" and last and lowest to "promising practices" (Services, 2003 cited in: Wolf et al, 2012).

Promising practise is defines as

> *"A promising practice is one that has worked in one organisation, corroborated by subjective and objective data and has a potential for replication in other organisations" (Services, 2003 cited in: Wolf et al, 2012).*

Evidence based practices are now being applied to other fields, such as Education, Information systems and Software Engineering. Due to multiple factors, not all solutions or practices available to Software Engineering practitioners adhere to the rigour that the medical practices have in strength of evidence. Hence, it is argued here that the practices reported by the survey participant should be taken as promising practices because these IT practitioners either work in Enterprise class IT environment or work with Enterprise scale clients providing enterprise IT service, thus their experience can be replicated in other Enterprise scale IT environments.

4.5 Limitations of Survey

How valid are the finding of the Survey research? There are a number of limitations with the survey research. The survey questionnaire explored the perceptions of IT practitioners regarding the challenges they faced during Enterprise Cloud deployment and about the practices in overcoming adoption challenges. These perceptions and experiences have not been verified directly, as what experts say may not be necessarily the key adoption challenge. Researchers (Kitchenham *et al.*, 2002) believe that survey data is reliant on self-reported observations thus there would be difficulties in sampling which includes sampling bias and subjective opinions in the collected data. Furthermore, practitioner's perceptions and opinions may not be entirely accurate as this research uses survey data that is self-reported information.

Wohlin, Höst & Henningsson (2003) describes construct validity as the relationship between the concepts and theories behind the experiment. In my view, the survey instrument holds the construct validity because the attributes it measures are based on published work of researchers who have experience with empirical data and its acquisition. The survey questions have adopted the same line of questioning as other researchers (Ehie & Madsen, 2005; Babar & Zhang, 2009; Khan, Niazi & Ahmad, 2012) seeking perceptions of participants and the variables were drawn from the SLR's result conducted in earlier research phase. The responses from the survey participants are evident that they found the questions relevant to their work.

The survey was piloted within a PhD research group and with a professional with similar profile as targeted participants. The survey questions were revised after the feedback, IT industry specific terms were changed and ambiguities in language were removed. This exercise of piloting is in line with the suggestion that piloting mitigates the internal validity threat caused by unfamiliar language or terms (Creswell, 2009).

Are the results of the survey generalizable? The sample is random but the respondents from Education sector are dominant. This might look as an external validity threat to the results of survey and compromise its generalizability on whole but I would argue against it. Firstly, by ensuring that two diverse groups are made part of participants, this risk is mitigated. Secondly, the respondents in Group B represent the Cloud vendor implementation partners, thus generalisation

can hold as most of the client organisations are from different industrial segments. It should also be noted that Enterprise class organisations tend to work with Vendor's partner and not directly with vendor itself for example Microsoft's Cloud implementation are done through their Gold or Silver partners, not by Microsoft itself directly. Thirdly, Clouds does come free or heavily subsidised to Education sector, but still all other risks faced by a commercial organisation remain the same in Educational institutions.

4.6 Chapter Summary

The results of the survey responses have provided three types of data sets:

1) Demographical data that is presented in Sections 4.2.2 to 4.2.6, this data provided respondent background, details of their organisations, their years of experience and their job roles.

2) Second set of data is the IT practitioner views on the challenges from their experience in deploying Cloud services or migrating existing service. They were asked to rate their agreement on the issues they face while Cloud deployment. These issues were identified from the SLR's results as 27 key issues and concerns that challenge the adoption of Clouds. This validated the challenges reported in the literature. The 27 key challenges reported in literature were either agreed by IT practitioners or disagreed, identifying the final 15 key challenges in the adoption of Clouds (See Table 37). All the key challenges are labelled and tabulated with percentage agreement of the IT practitioners. The ECAAM model ensures that its assessment constructs measure readiness of the organisation to overcome these 15 key challenges.

3) Third dataset is the tacit knowledge of the IT practitioners about the actions, practices and techniques that they have applied in overcoming these challenges. Several open-ended questions in the survey questionnaire helped in gaining this tacit knowledge from the respondents. Some of the industrial practices (discussed in Section 4.4) are: using open source APIs to access Cloud services, involvement of legal team in vendor selection process, identification of the workflows/processes to change, involvement of senior executive as change champion, using Re-seller/Vendor partners support for application/service migration to Clouds, develop Cloud service quality feedback mechanism etc.

Chapter 5: Enterprise Clouds Adoption Assessment Model

"If you don't know where you are, a map won't help" Watts Humphrey

Introduction

This chapter presents the outcome of this research study and the main contribution, the Enterprise Clouds Adoption Assessment Model (ECAAM). The model is developed adapting approach from existing readiness assessment models in literature. The assessment constructs of ECAAM are based on the key challenges in the adoption of Enterprise Cloud and practices of the IT Practitioners that have helped them in overcoming the challenges.

This chapter is segregated into two major sections. The first section discuss the development of the model, mapping of its areas with the evidence collected in earlier chapters and second part discusses the aim and purpose, measures and interpretations of the model results. A section is introduced that discusses the model's trial in industrial settings.

5.1 Model Development

An examination of the Enterprise Cloud Computing and organisational readiness assessment literature highlighted the need to develop a model/framework that can assist practitioners in successful implementation of Cloud. The study's objectives proposed an organisational assessment model that would be theoretically robust and vigorous in terms of measuring organisational readiness for adoption of Enterprise Clouds. Development of the ECAAM answers the **RQ3 (Refer to Chapter 1 Sec 1.2)** as well as ECAAM is an assessment model that can measure readiness to overcome the adoption challenges.

5.1.1 Development Approach

For developing an assessment or measurement model there are two approaches in literature: top-down and bottom-up approach (Maxwell, 2005). In the top down approach a heuristic model is first conceived and then its assessment constructs were added, whereas, in bottom-up approach the development is done from individual assessment construct to the whole model. Psychology describes bottom-up as the best approach as "things, people, ideas and the whole universe evolved bottom-up: from the simple to the more complex" (Tompkins, Sullivan & Lawley, 2005).

A top down approach was used in developing Organizational Information Technology Innovation Readiness Scale (OITIRS) (Snyder-Halpern, 2002) where heuristic model was developed initially. The model's indicators were explored from literature and were validated thru a Delphi study (Snyder-Halpern, 2002).

Electronics Health Records - Organizational Readiness Tool (EHR-ORT) (Cherry & Owen, 2008) was developed by firstly identifying the factors that facilitate or impede EHR's implementation by an SLR. The identified factors were then validated thru a focus group session with IT experts to identify factors that facilitate or impede EHR's implementation. The EHR-ORT model was then developed based on factors.

ECAAM model is developed using a bottom up approach and was carried out in two steps (See Figure 18)

- First step was the collection of 1) key adoption challenges in the adoption of Enterprise Clouds validated by IT practitioners and 2) the practices suggested by IT practitioners in overcoming the challenges in adoption of Enterprise Clouds. This involved using the SLR and survey methods for data collection and validation.
- Second step was to make assessment construct from the practices. The assessment constructs are developed to evaluate that industry preferred practices that overcome the key challenges are being followed/used or not. The foundations of the ECAAM are the practices that help in overcoming the key challenges in the adoption of Clouds. The model also pulls its assessment constructs from other organisational assessment model i.e. from OITIRS, EHR-ORT etc. (Refer Chapter 2 Section 2.1.3)

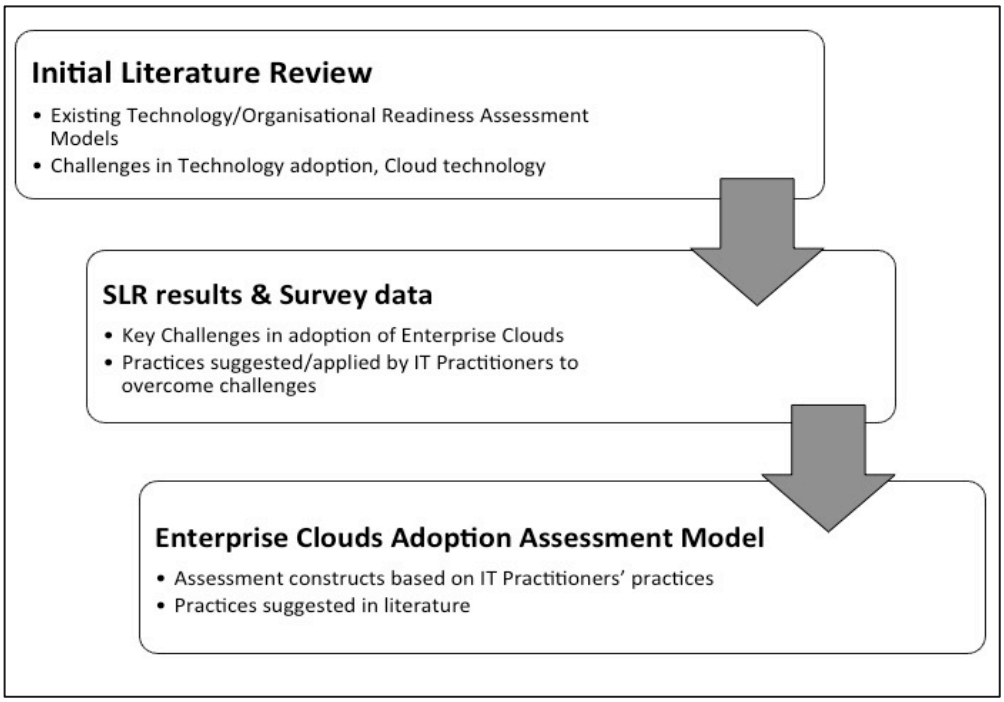

Figure 18 ECAAM's development steps

5.1.1.1 Guiding principles

ECAAM is designed as a complete assessment methodology where the evaluator is informed of the assessment score, procedure of conducting assessment and interpretation of results. There were 4 guiding principles suggested by Hansen *et al.* (2015) that were adhered during the development of model.

The guiding principles for ECAAM's development are:

- ***Adequacy***: ECAAM should be adequate to deliver a sound and valid judgement on the Enterprise Clouds adoption readiness of the organisation under evaluation.
- ***Ease of use****:* ECAAM should be easy to use with clear and unambiguous instructions. The results should be recorded and the assessment should be performable with little or no organisational overhead.
- ***Effort:*** The effort required to perform an assessment using ECAAM should be reasonable.
- ***Effectiveness of the scale:*** ECAAM should be based on scales that should be effective and useful in practice. Hansen *et al.* (2015) defines the effectiveness of a

scale by four factors: comprehensibility, comparability, scorability and reproducibility. Firstly, comprehensibility is that scale's scoring should be easy to apply and understand by the evaluator, secondly the comparability of scale is that the comparing of different scores should be relatively straightforward (Hansen *et al.*, 2015). Hansen *et al.* (2015) defines scorability of a scale as that it should be easy to score objectively on the given scale and finally, reproducibility of score where an assessment should receive nearly same score when scored by two or more evaluators.

5.1.1.2 Model's Assumptions

There is always a need to make some assumptions about the system in order to construct a model (Snyder-Halpern, 1998). ECAAM is a readiness assessment tool and does not support the adoption decision rather it is to be used when the Enterprise has taken its decision to use Clouds and is in a planning phase to implement the services. These assumption are drawn based on the nature of the model and are adapted from prior literature i.e. (Snyder-Halpern, 2001).

The following are the assumptions of the ECAAM model.

- Decision to migrate IT services or deploy new Cloud based services has been taken. ECAAM is developed as a tool that can help in evaluation of readiness and guiding the implementation decisions.
- Enterprise should be using either Public Cloud or Hybrid Cloud deployment model. Majority of the concerns and issues identified in this study are based on the premise that Cloud Computing services are third party services (Refer to Chap 3).
- Employees/End-users are made aware of the new technology decision through formal organisational communication channels (Email of CEO/Internal Magazine etc.). The concerns of end-users or IT staff would only come to surface when they would be formally announce about the decision to migrate.

5.1.1.3 Readiness Dimensions

Segregation of model's items into dimensions or logical clustering is a dominant approach seen in reviewed literature and other models (i.e. OITIRS, EHR-ORT). Following this, ECAAM's assessment constructs are divided into four aspects here forth referred as dimensions. A dimension is an aspect within the organisation including its infrastructure, people and processes where the adoption issue or concern happens. The readiness in any particular dimension reflects that there is a facilitating environment within that functional area/people/process to adopt the Cloud services.

The four dimensions and their definitions are:

- **Technical readiness:** Where technical readiness is assessed to see that the organisation is ready for implementing Enterprise Clouds and is following the practices that can overcome technical challenges that are barrier to the adoption of Enterprise Clouds.
- **IT Capability Readiness:** Where IT department's and staffs' readiness is assessed to see that staff, processes and department is ready to overcome issues/challenges that are barrier in the adoption of Enterprise Clouds.
- **End-User's Readiness:** Where End-user's readiness is assessed to see that they (the people) are ready to overcome issues/challenges and their concerns are addressed that are barrier in the adoption of Enterprise Clouds.
- **Legal & Compliance Readiness:** Where readiness is assessed to see that actions are taken to ensure all legal and compliance related issues are addressed that are barrier in the adoption of Enterprise Clouds.

5.1.1.4 Mapping Readiness dimensions to adoption challenges

The four readiness dimensions described above cover the readiness assessment in overcoming the challenges. Note the following figure (See Figure 19 pg143) presents the four readiness dimensions and the challenges assessed under each dimension. Arrows represent coverage of the dimension of the themes of the key challenges in the adoption of Enterprise Clouds.

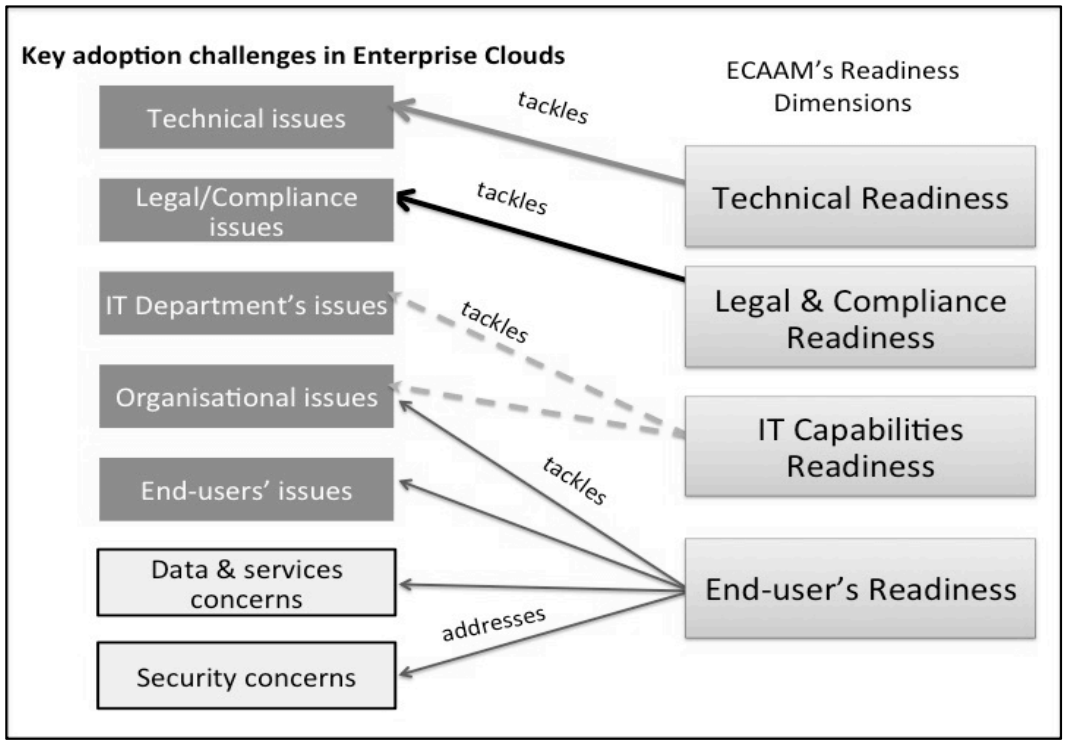

Figure 19 Mapping ECAAM's readiness dimensions and adoption challenges

For measuring, Technical readiness there are 9 technical issues i.e. Cloud implementation issues, IT infrastructure issues and IT service issues that are challenges in the adoption of Enterprise Clouds and the 17 assessment constructs assesses readiness to overcome these challenges. Meanwhile, some of the constructs not only assess technical issue but also help in assessing other issues and concerns such as vendor management issues, legal & compliance issues, availability concerns, reliability concerns, data privacy concerns and security concerns.

Legal & compliance readiness focuses on overcoming legal & compliance issues that are barrier in adoption of Clouds, however they also focuses on overcoming people's lack of legal awareness. IT Capabilities readiness and End user readiness both assess readiness to overcome issues related to End User issues, IT Staff issues, Organisational Change, Organisational Issues and Vendor management issues that are challenges in adoption of Enterprise Clouds. The 12 constructs of IT capabilities lay assessment emphasis on IT people and IT department, where as 13 constructs of End users' readiness focus on End users' as people and their readiness. The other 10 End users' readiness constructs are developed that lay their assessment emphasis on addressing people's concerns related to data, service and security.

5.1.2 Developing Assessment Construct

5.1.2.1 Technical Readiness Assessment

An Enterprise and its implementation team should have the ability to successfully implement the Cloud technology within the organisation. For this they have to be able to carry out right technical actions that would help in overcoming the technical challenges associated with Clouds implementation or service deployment.

The assessment constructs that assess technical readiness are drawn from literature and survey's results (IT practitioners' promising practices). The assessment emphasis is placed on performing the action and brining readiness in 6 areas related to Cloud technology implementation; the areas are: conducting technical assessment, managing existing application migration, mitigating vendor lock-in risk, monitoring Clouds' Quality of Service (QoS), implementing Clouds specific security and using vendor's support. The following table present the assessment construers and their themes.

Table 43 Technical readiness assessment constructs

Enterprise Clouds Adoption Assessment Model (ECAAM)	
Technical Readiness Assessment constructs	
Themes	**Constructs**
Conducting Technical Assessments	Pilot testing for operational feasibility
	Data & Work critically assessment
	Bandwidth Needs assessment
Managing existing application migration	Interconnected systems are not migrated
	Technical audit for service/application migration issues
	Reseller/Vendor support for migration
Mitigating Lock-in risk	Gaining Clouds interoperability
	Using Middleware to avoid vendor lock-in risk
	System duplication on standby node
Monitoring Clouds QoS	Vendor performance investigation
	Performance monitoring deployment
	Cloud specific performance KPIs
	New service feedback mechanism
Implementing Cloud specific Security	Implementing secure communication protocols
	Following Vendor's security guidelines
Using vendor's technical support	Quality of support for technical issues
	Vendor's premium support services

Carrying out technical assessments before Clouds helps in being better prepared for Clouds. Pilot testing is a traditional way of measuring suitability of any new technology and can help decision makers to judge the feasibility of operationalization of the new services. Simalango, Kang & Oh (2010) recommends that potential Public Cloud services should be piloted test within a limited group of users to see its fitness for purpose. Reflecting on their experience, 79% of the IT practitioners reported in survey that pilot testing was carried out before implementation (Refer to Chapter 4 Sec 4.4.4). This practice helps in overcoming the challenge of incompatibility of existing infrastructure, as it would assess the existing IT infrastructure for its fitness to take on Cloud services.

Similarly, an assessment of data sensitivity & criticality of work before implementation would help IT Managers or decision makers in 1) making informed decisions and 2) bring clarity about what data/work related concerns would emerge while/after implementation of Cloud services (Kim, 2009). 47% of the survey respondents (IT Practitioners) confirmed that assessment of data/work was carried out before implementation of Clouds (Refer to Chapter 4 Sec 4.4.4 pg 130).

An assessments of future bandwidth needs for Clouds would help in overcoming the challenge of incompatibility of existing IT infrastructure, as IT Managers would have a fair idea that how much they need to upgrade for which services. There are several ways to measure bandwidth needs by applying generally available rule of thumbs (Bright, 2013), however IT practitioners general understanding is to assess Cloud based internet/network bandwidth needs based on users, services and locations. Carrying out an assessment of network bandwidth need would also help in resolving concerns about increase in IT department's operational cost.

Managing existing application migration would help in overcoming several key challenges i.e. migration of existing applications, issues with legacy application etc. Legacy systems and other application with high number of interconnects are difficult to migrate should not be migrated to Clouds (Hosseini, 2013). Hosseini (2013) suggest conducting technical audit to investigate system integration issues.

To measure the readiness in the area of managing existing application migration, an construct is added that asks about using the support provided by the Cloud Vendors' partners. The

items is added to ECAAM, based on recommendations of IT practitioners that Vendor's partners support helps in overcoming issues in migration of existing application (Refer to Chapter 4 Section 4.4.1 pg 122).

Adler (2012) recommends that duplication of System would bring resilience in Cloud service. This replication can be done on another Cloud vendor as a stand by node. Moreover, the cost of this duplication would be minimal as Cloud services are paid by usage. This approach would increase departmental capability to interoperate between Cloud services and vendors, as replication would require using other Cloud vendor.

To assess readiness on the ability to mitigate the Vendor/Service Lock-in risk, three assessment items were added to ECAAM's technical readiness dimension. These actions not only help in avoiding vendor lock in risk they also help in adding capabilities in the IT System to interoperate among multiple Public Clouds.

The three items in the assessments are:

- Using Middleware compatible with multiple Clouds as it helps to avoid vendor lock-in risk
- Using of http/https APIs or open source APIs for Cloud to gain interoperability among Clouds
- Duplicating System on another Cloud as Stand by node.

Quality of Service (QoS) monitoring is key for success of Cloud services as it assesses the actual quality of the service that is being paid for (Giuseppe *et al.*, 2012). However, monitoring is a complex task as it is based on complex individual components and interconnection of multiple Systems.

To overcome the adoption challenges i.e. decrease in performance of service after migration of Clouds and Lack of QoS/SLA monitoring tools, IT practitioners and literature suggest several practices.

New Key Performance Indicators (KPIs) for the Cloud services should be developed or used (Giuseppe *et al.*, 2012; Firdhous, Hassan & Ghazali, 2013). Giuseppe *et al.* (2012) developed a Cloud-based Cloud monitoring service. Observation of Clouds services from outside ensures better performance monitoring. This notion is also supported by Hosseini (2013) as he too recommends that QoS monitoring tools should be placed outside of Clouds.

Khajeh-Hosseini, Greenwood & Sommerville (2010) suggest that Clouds performance should be investigated before adoption providing a baseline to measure future performance.

Based on ITIL's service delivery guidelines, customer feedback should be essentially updated for new service (GENROE, 2015). This ensures that appropriate feedback of service customers (end-users in this case) is collected for new service. The complaint record can also be used for monitoring performance of the new Cloud services.

To assess readiness in ability to overcome challenges that relate to performance of service or Quality of service of Clouds is an essential factor. The items used to assess readiness are:

- Cloud vendor's performance was investigated before migration and would be monitored continuously.
- Tools monitoring service quality are deployed outside the systems to monitor Cloud service performance.
- Cloud services performances KPIs are developed/used to monitor quality of Cloud service
- A new feedback mechanism for Cloud service has been provided to end-user to note their feedback

Implementing Cloud specific security is a practice that helps in overcoming security concerns and also makes accessing the Clouds more secure for organisation. It is suggested to use multi-factor authentication and VPN's for accessing Clouds (Bisong & Rahman, 2011), whereas Vendor's guidelines for security and authentication must be followed (Hosseini, 2013). Several vendors such as Amazon offers free support for their customer's security implementations. *Two constructs were added to ECAAM to assess readiness in implementing Cloud specific security.*

To overcome implementation issue it is important that Vendors' technical support is sought, as it would help to overcome difficulties in migration of existing Systems. The availability of good quality of support is an important factor supporting migration activities increases readiness (Snyder-Halpern, 2001). Access to premium/special support is also helps in overcoming challenges in the migration of application and services on Clouds, provided at a cost by some vendors (Hosseini, 2013). *Two assessment items were added to ECAAM based on the indicator of availability of quality support and the practice of subscribing to premium support (Hosseini, 2013)*.

In total, there are 17 assessment constructs, in the technical readiness dimension of ECAAM.

5.1.2.2 Legal & Compliance Readiness Assessment

An organisation faces issues from the environment it operates in and these environmental factors, which are beyond its control, can be barrier in adoption of technology (Davis, 1989). In the SLR's results, Legal and Compliance issues were the environmental issues that are barrier in adoption of Cloud technology. Bringing readiness in Legal/compliance dimension helps an organisation to be more compliant with existing rules and legally protected. Besides organisational readiness in securing its own interest, employees' awareness is also a crucial factor (Antonopoulos *et al.*, 2010). As discussed in SLR's results, the legal and compliance issues revolved around legal jurisdiction over data, physical location of data, compliance with EU directives etc. (Refer to Chapter 3 Sec 3.3.3).

For assessing the organisational readiness in this dimension, 8 constructs are added to the ECAAM. The themes and constructs are tabulated in the following table (See Table 44).

Table 44 Legal/Compliance readiness assessment constructs

Enterprise Clouds Adoption Assessment Model	
Legal/Compliance Readiness Assessment constructs	
Themes	**Constructs**
Ensuring compliance with rules	Conducting independent Cloud/IT system audits for compliance
	Updating information security policies/procedures for Clouds,
	Asking vendor about compliance
Pursuing Legal coverage	Keeping data in legal jurisdictions
	Involving Legal team in drafting SLA
	Data confidentiality in SLA
Creating Employee awareness on legal issues	Awareness of legal responsibility
	Informing when non-compliance

To assess that the Enterprise is compliant with rules and regulations, three constructs are added. The first construct asks the respondent about conducting independent IT/IS System audits with a focus to audit Cloud services' compliance. Independent or third party IT/IS system audit highlights security and compliance issues (Arturo & Jose, 2000). Cloud Security Alliance's Cloud Control Matrix (CCM) is an industry standard for assessing Cloud related information security risks. CCM draws from several other industrial standards such as ISO 27001/2, European Network Information Security Association's Information Assurance Framework etc. (CCM Working Group, 2013). CCM advises several ways of adding Cloud specific security & controls, compliance and creating end users' awareness.

- The first assessment construct is based on CCM's recommendation that Clouds systems should be audited by third party at least annually to check for regulatory/statutory compliance. This would ensure that Cloud services and controls are compliant with regulations (CCM Working Group, 2013).
- Second construct is also a CCM's recommendation that information security policies and procedures should be updated to reflect Cloud services and compliance (CCM Working Group, 2013). Although assumingly an Enterprise would have an information security policy and procedures, but ensuring that they are updated to reflect Cloud specific regulations would ensure compliance across all information system users and organisational levels.

- Third construct is about the practice of asking vendor to demonstrate their Compliance and Security certifications. These certificates or information could be distributed across stakeholder to elevate fears and could also bring to light any shortcomings from vendor's side.

One legal issue reported in literature was related to the EU laws that enforce data's physical placement within a specific geographical bound (EU's directive about Europe) (refere to Chapter 3 Sec 3.3.3). A construct is added to ECAAM asking the respondent: "*Was the vendor explicitly asked to keep data in legal jurisdiction?*". This would assess that the organisation is secure legally as it has discharged its duty and this would perhaps become part of SLA. Some vendors now offer explicitly placing their client's data on data center within geographical bounds of their choice (Microsoft has an Azure data center in Ireland for EU based clients).

To overcome legal issues, respondent of survey research suggested that the legal teams/lawyers must be involved in drafting of Service Level Agreement (SLA) or Operational Level Agreement (OLA) and contracts with Cloud vendors (Refer to Chapter 4 Sec 4.4.1 pg122).

Last two-assessment constructs relate to creating awareness amongst employees about legal issues on using Clouds. CCM defines two major controls in this regard, making employee aware of their legal responsibility and ensuring that their explicating consent is sought in case where data storage is non-compliant (CCM Working Group, 2013; Hosseini, 2013).

5.1.2.3 IT Capabilities Readiness Assessment

In IT capabilities readiness the assessment emphasis is placed on assessing readiness of IT staff and IT department. Based on key challenges reported in SLR's results in adoption of Clouds, the key challenges as organisation issues were segregated as issues concerning IT people and IT department. This assessment measures readiness in overcoming those challenges by seeing how well the IT staff is ready to change, how the risk or losing IT people is mitigated and how well in the department staffed to manage future work load. The constructs have four themes: creating Cloud implementation support, changing the processes, mitigating loss of IT capabilities risk and managing the IT staffing (See Table 45).

Table 45 IT Capabilities readiness assessment constructs

Enterprise Clouds Adoption Assessment Model	
IT Capabilities readiness assessment constructs	
Themes	**Constructs**
Creating Cloud Implementation support	Inputs of current IT staff in implementation plan
	Support/Resources for implementation
	IT Staff sharing project success
	Current staff as part of implementation team
Changing processes	Executives identified IT processes to change
	Updating vendor management process
Mitigating IT capabilities loss risk	Likelihood of IT Staff turnover
	Training for new skills
	Defining new roles and responsibilities
	Incentive to accept change in work pattern
Managing IT Staffing	Adequacy of IT staff
	Future staffing needs

Creating Cloud implementation support is an assessment scale drawn from Organisational readiness to Change Assessment tools developed by Helfrich *et al.* (2009). This readiness assessment tool defines a scale to measure the internal facilitation provided to local implementation teams or organisation, as internal team acts as a major point of interface with external facilitator. If an internal team is not made part of a project or they are not valued then success of overall implementation of the project would suffer (Helfrich *et al.*, 2009). Thus, a set of assessment constructs was added to ECAAM, to measure IT staff's (internal team here) readiness to facilitate the implementation of Clouds deployment project. Besides IT staff role in implementation team, another important factor is resource and support for the implementation project. The adequacy of resource and support ensures that organisational commitment exists for the project (Snyder-Halpern, 2001). Similarly, an assessment construct was added to this dimension based on suggestion of an IT practitioner who was participant of the survey, where the respondent felt that giving value to current staff in implementation project is an essential factor in success of the project (Refer to Chapter 4 Sec 4.4.1 pg 122).

These constructs overcome the challenges of IT staff's resistance to change. To measure the readiness, the construct used here are:

- Inputs of current IT staff in implementation plan
- IT Staff sharing project success

- Support/Resources for implementation
- Current staff as part of implementation team

Snyder-Halpern (2001) believes that process readiness is a fit between the IT innovation characteristics and existing processes. The low level of readiness would be indicative of need for process changes, lack of process identification or mismatch of processes (Snyder-Halpern, 2001). The vendor management processes must be changed to accommodate the new Cloud services as suggested by Khajeh-Hosseini *et al.* (2012). To measure the level of readiness of process changes within IT department, two constructs were added.

- Have the executives identified IT processes to change.
- The vendor management process was updated or not.

Mitigating IT capabilities loss risk concerns action that ensure that IT department do not suffer due to loss of IT expertise or capabilities. The practices that help in mitigating the risk of losing IT staff is to be aware about turnover, staff concerns and knowing that there is a likelihood of staff turnover (Hosseini, 2013). Staff can be retained by providing them training, incentives to adapt to change in work patterns and a clarity in their roles and responsibilities (Lehman, Joe & Simpson, 2002; Hosseini, 2013). The assessment constructs are:

- Likelihood of IT Staff turnover
- Training for new skills
- Defining new roles and responsibilities
- Incentive to accept change in work pattern

IT staffing is focused on the number of current IT staff members available to do the work and future needs of staff members. The two statement that relate to IT staffing in this dimension are:

- "There are enough IT staff to meet current support needs" and
- "Executives are aware of future staffing needs for supporting Cloud services."

In total, there are 12 assessment constructs, in the IT capabilities readiness dimension of ECAAM.

5.1.2.4 End-users' Readiness Assessment

End-user readiness is focused on assessing readiness in End users of the Cloud services. This dimension has the largest number of assessment constructs (23 of total 60) in ECAAM. The statements in this dimension seek responses on degree of agreement scale with 1 score for Strongly Disagree to 6 score for Strongly Agree, with zero for no opinion.

The constructs have five themes: Communicating with Employees, Employee adaptability, Providing training to Employees, Creating awareness about Cloud services and Addressing Employee Concerns. These constructs measure effectiveness of communication plan, employee adaptability, provision of training, information sharing to create awareness on Clouds and address employees' concerns (See Table 46 next page).

Table 46 End users readiness assessment constructs

Enterprise Clouds Adoption Assessment Model	
End user readiness assessment constructs	
Themes	**Constructs**
Communicating with Employees	Sharing of Vision Document
	Staff has clarity on migration objectives
	Staff can raise questions and concerns about IT
	Staff are kept informed about IT services
	Senior Executive as Change champion to engage in activities
Employee adaptability	Staff sharing their technical knowledge with each other
	Staff willing to try new ideas
	Employees have positive attitude towards Clouds
Providing training to Employees	Providing on-line resources for updating skills
	Arranging hands-on training opportunities to apply Cloud services
	Asking employees' preference on type of training on Clouds
	Education/Training are priority in organisation
	Emphasis on interdisciplinary teams for Cloud related training
Creating awareness about Cloud services	Creating awareness about Vendor's capabilities
	Creating awareness about data location and transmission
	Create awareness about service disruptions and impact
	Create awareness about data ownership and responsibilities
	Create awareness about of Cloud services disruption and resumption times
Addressing Employee Concerns	Policies and procedures for data storage on Clouds
	Staff are encouraged to use encryption for data on Clouds
	Providing Employee with service & performance statistics
	Executive talking to employees about concerns related to Clouds
	IT Executives informally meet up with employees to discuss Clouds

A major challenge in adoption of Clouds is the End-users' resistance to change. One action that could help in overcoming resistance to change is to give clear message to employee about the need for change and impact of change (Armenakis, Harris & Mossholder, 1993).

The clarity of mission and goals increases employees' awareness of organisation's mission and lead to more involvement from them (Lehman, Joe & Simpson, 2002). Sharing the Cloud migration project objectives, involvement of senior executive in dissemination activities, effective usage of communication channels and mediums to share information can send out the message to employees effectively.

The items in the ECAAM that measures End-users' readiness are:

- Sharing of Vision Document with Cloud project's goals
- Staff has clarity on Cloud migration objectives
- Staff can raise questions and concerns about IT
- Staff is kept informed about IT services
- Senior Executive as Change champion to engage in activities

Employee adaptability is the ability of staff to adapt to the changing environment (Lehman, Joe & Simpson, 2002). As change impacts behaviour, a positive attitude towards change would make people less resistive towards new technology (Holt *et al.*, 2007). The assessment constructs measure the perceptions about the adaptability of employee.

The constructs are

- "Staff frequently shares their technical knowledge or new technical ideas with others staff members",
- "Some staff members are willing to try new ideas even if others are reluctant" and
- "Employees have a positive attitude toward Clouds implementation".

In IT practitioner views, End-user training was an effective approach to address end user concerns about Clouds and it also increases adoption of technology (Refer to Chapter 4 Sec 4.4.2 pg 127).

The constructs are:

- Providing on-line resources for updating skills
- Arranging hands-on training opportunities to apply Cloud services
- Asking employees' preference on type of training on Clouds (Knight, 2015)
- Education/Training are priority in organisation (Lehman, Joe & Simpson, 2002)
- Emphasis on interdisciplinary teams for Cloud related training (Snyder-Halpern, 2001)

One segment of End-user readiness is to assess how effectively people's concerns related to Cloud technology are addressed in the organisation through awareness and by application of suggested practices. Cloud Control Matrix suggests several actions to create awareness in employees regarding Clouds, specially Cloud storage, security and awareness of their own responsibilities (CCM Working Group, 2013).

The readiness is assessed by 10 constructs with two themes: Creating awareness about Cloud services and addressing employee concerns.

- Creating awareness about Vendor's capabilities (Hosseini, 2013)
- Creating awareness about data location and data transmission (Hosseini, 2013)
- Create awareness about service disruptions and its impact (CCM Working Group, 2013)
- Create awareness about data ownership and responsibilities (CCM Working Group, 2013)
- Create awareness about Cloud services disruption and resumption times (CCM Working Group, 2013)

Address employees concerns relates to actions that alleviate employees' data, services and security concerns on using Clouds. An organisation should disseminate policies and train its staff about procedures on data storage, data deletion and retention on Clouds and encourage using encryption (CCM Working Group, 2013). Sharing of performance and monitoring data also helps in addressing concerns related to third party service and fear of data loss (Hosseini, 2013).

Last two constructs are based on IT practitioners' suggestion that top management must directly engage with employees to discuss their concerns and IT executives should have informal chats in this regard.

The constructs are:

- Policies and procedures for data storage on Clouds
- Staff are encouraged to use encryption for data on Clouds
- Providing Employee with service & performance statistics

- Executive talking to employees about concerns related to Clouds
- IT Executives informally meet up with employees to discuss Clouds

5.1.3 Scale items

ECAAM is designed as a 60-statement survey form (See Annex E for ECAAM's form). The form has 60 statements. For each individual assessment construct there is an item (statement) in the model. An item is a sentence that represents an action or practices or question to be answered by the ECAAM's respondent. Each statement is coded according to its dimension for easier identification and scoring.

Dimension	Items	Code
Technical Readiness	17 items	T-01 to T-17
IT Capabilities Readiness	12 items	IC-01 to IC-12
End-user's Readiness	23 items	EU-01 to EU-23
Legal & Compliance Readiness	08 items	L-01 to L-08

5.1.3.1 Statements and scoring

In the ECAAM is each statement has two types of assessment scores, based on their response on agreement scale rating or binary yes/no answer (See Annex E)

Items in Technical readiness dimensions are statements that require "Yes" or "No" answers. The score for no answer is 0 and yes is 6. The choice of response for all the statements in the technical readiness dimension is a clear-cut binary yes/no answer.

Example:

Enterprise Clouds Adoption Assessment Model					
Technical Readiness					
Code	Statement	Response			Score
		No	Yes	No Opinion	
T-01	A pilot deployment was conducted to see operational feasibility		y		6

For all other statements in other three readiness dimensions, a Likert type agreement scale is used. The score for the agreement scale is from 1 to 6, with 1 for strongly disagree and 6 for strongly agree.

Example:

Enterprise Clouds Adoption Assessment Model									
End-user's Readiness									
		Response							
Code	Statement	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree	No Opinion	Score
EU-01	Vision document detailing Cloud migration goals is shared with all employees		y						2

Moreover there is a no opinion choice for each statement that is scored as zero; this ensures that the statements where the respondent has no information or thinks that it is not applicable to their organisation are not made a part of scoring.

The maximum score of the ECAAM is 360 based on all the items. Individual dimensional score are:

Dimension	Items	Code
Technical Readiness	17 items	Maximum score of 102 (6 * 17)
IT Capabilities Readiness	12 items	Maximum score of 72 (12 * 6
End-user's Readiness	23 items	Maximum score of 138 (23 * 6)
Legal & Compliance Readiness	08 items	Maximum score of 48 (8 * 6)

The result interpretation is adapted from Motorola Readiness assessment tool which interprets its scores in ranks or levels (Daskalantonakis, 1994).

There are two scores to be calculated and interpreted:

1) Dimensional score

- Calculation of score is sum of score of each item within dimension scaled to 10
- Individual dimensional score ranges from 1 to 10 for each dimension where score below 5 represents poor readiness in that particular dimension; score between 5

and 7 can be taken, as fair level of readiness and score above 7 is indicative of good level of readiness in that dimension.

2) Overall readiness percentage

- The overall readiness percentage calculates the organisational readiness as a whole to overcome the adoption challenges. Calculation is sum of all item score divided by maximum score.
- It is interpreted as that the Enterprise "X" is this much % ready to overcome the challenges that are the barrier in adoption of Enterprise Clouds.

5.1.3.2 Scale item mapping to key adoption challenges.

The following table (See Table 47) represent the scale item mapping to the key challenges to the adoption of the Enterprise Clouds. The 17 key challenges validated are addressed by ECAAM. Besides 17 key challenges, there are 5 technical that are also addressed by assessment constructs in the Technical readiness. These challenges were added to the ECAAM.

Table 47 ECAAM's items mapping to key adoption challenges

ECAAM's items mapping to key adoption challenges					
Key Challenge Code	**Challenges (Issues and concerns)**	**ECAAM's Readiness Dimensions**			
		Technical Readiness	**Legal & Compliance**	**IT Capabilities Readiness**	**End-user Readiness**
KC-1	Incompatibility of existing IT Infrastructure/Resources for Cloud Computing	T-01, T-02, T-03			
KC-2	Excessive effort is required to re-engineer legacy applications for migration on Clouds	T-04, T-05			
KC-3	Loss of control over IT resources after migration on Clouds	T-03			
*	Lack of interoperability between Cloud service or Cloud Vendors	T-07, T-09			
*	Cloud Vendor/Service lock-in issues	T-08			
*	Decrease in service performance after migrating services on Cloud Computing	T-10, T-11, T-13			
*	Difficulties in Application/Service migration to Cloud Computing	T-02, T-04, T-06, T-05, T-16, T-17			
*	Lack of sufficient migration support from Cloud Vendor	T-06, T-16, T-17			
*	Lack of QoS or SLA monitoring solutions	T-10, T-11, T-12			
KC-4	End-user resistance to change				EU-01 to EU-13
KC-5	Changed IT organisational work patterns			IC-05, IC-06, IC-10	
KC-6	IT Staff's resistance to change			IC-01 to IC-06	
KC-7	Loss of internal expertise (IT Capabilities)			IC-07, IC-08, IC-11, IC-12	

ECAAM's items mapping to key adoption challenges					
Key Challenge Code	**Challenges (Issues and concerns)**	**ECAAM's Readiness Dimensions**			
		Technical Readiness	**Legal & Compliance**	**IT Capabilities Readiness**	**End-user Readiness**
KC-8	Lack of organisational readiness			IC-01 to IC-06, IC-11	EU-09 to EU-13
KC-9	Change in IT Dept.'s role/authority			IC-07, IC-09	
KC-10	Increased dependence on a third party provider	T-09		IC-05, IC-06	
KC-11	Legal or Compliance issues in migrating to or accessing Cloud Computing		L-01 to L-08		
KC-12	Availability of service/Cloud vendor	T-09			EU-14, EU-15, EU-16
KC-13	Reliability of services offered by Cloud Vendor	T-09			EU-15, EU-16, EU-21
KC-14	Privacy of data stored on Cloud		L-03, L-07		EU-17, EU-19, EU-29
KC-15	Security concerns/apprehension about Cloud Computing	T-14, T-15	L-03, L-07		EU-14, EU-17, EU-22, EU-23

Note:
Key challenges in adoption are taken from Chapter 4 Sec 4.3
* Not a key challenge as not agreed by more than 50% of survey respondents but was significant in Clouds implementation. Refer to discussion in Sec 5.1.2.1 in this regard.

5.2 Enterprise Clouds Adoption Assessment Model

Enterprise Clouds Adoption Assessment Model (ECAAM) is a model that helps an Enterprise in measuring its readiness to overcome the adoption challenges for a successful organisational adoption of newly deployed/migrated IT services on Enterprise Clouds.

ECAAM

- helps an Enterprise assess readiness of four of its functional areas where it should take actions to overcome the adoption challenges.
- supports the decision makers/IT Management to judge the possibility of success of their implementation effort or planning by increasing the adoption of new Cloud services
- helps decision makers and stakeholders become knowledgeable about the characteristics of Enterprise Clouds as a technology.

The model focuses on overcoming the key challenges in adoption of Enterprise Clouds by assessing the organisation's readiness in four dimensions. The four dimensions are Technical, IT Capabilities, End-user and Legal & Compliance.

The diagram depicts the ECAAM model, outer circle represents the four readiness dimensions and the inner circle represent the adoption challenges each dimension tackles (See Figure 20).

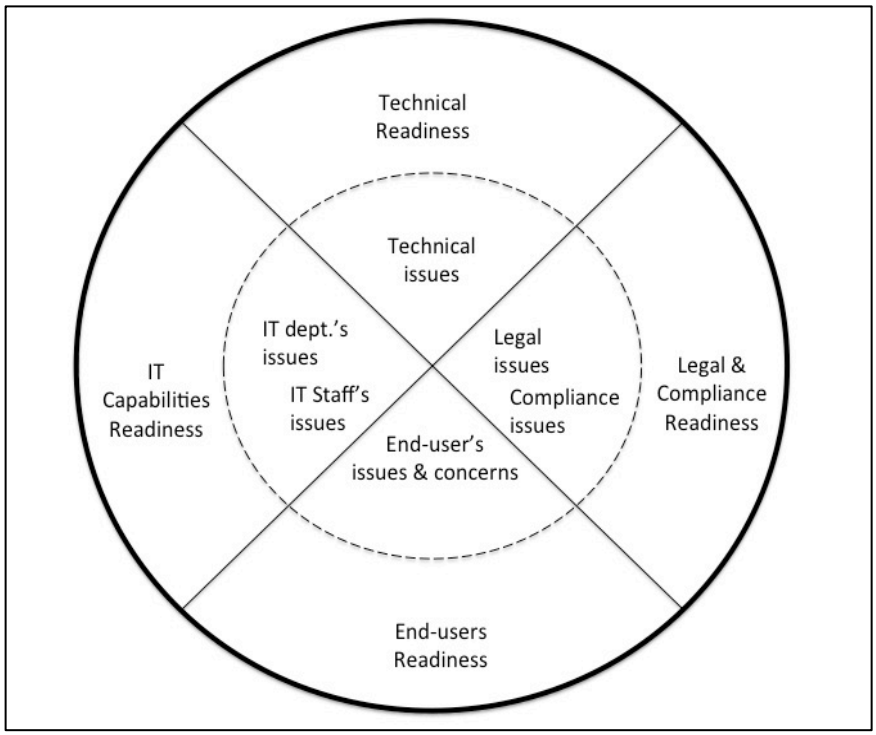

Figure 20 Enterprise Clouds Adoption Assessment Model

- Technical readiness: Where technical readiness is assessed to see that the organisation is ready for implementing Enterprise Clouds and is following the practices that can overcome technical challenges that are barrier to the adoption of Enterprise Clouds. The ECAAM assessment tool gives a score from a scale of 1 to 10 in this dimension.

- IT Capability Readiness: Where IT staff's and IT departmental readiness is assessed to see that staff, processes and department is ready to overcome issues/challenges that are barrier in the adoption of Enterprise Clouds. The ECAAM assessment tool gives a score from a scale of 1 to 10 in this dimension.

- End-User's Readiness: Where End-user's readiness is assessed to see that they (the people) are ready to overcome issues/challenges and their concerns are addressed that are barrier in the adoption of Enterprise Clouds. The ECAAM assessment tool gives a score from a scale of 1 to 10 in this dimension

- Legal & Compliance Readiness: Where readiness is assessed to see that actions are taken to ensure all legal and compliance related issues are addressed that are barrier in the adoption of

Enterprise Clouds. The ECAAM assessment tool gives a score from a scale of 1 to 10 in this dimension.

Individual dimensional score ranges from 1 to 10 for each dimension where score below 5 represents poor readiness in that particular dimension; score between 5 to 7 can be taken as fair level of readiness and score above 7 is indicative of good level of readiness in that dimension.

The overall ECAAM score is used to calculate the overall score percentage value that reports the overall readiness of the organisation for adoption of Enterprise Clouds. Higher percentage value >= 60% is a predictor that Enterprise is ready for this technology innovation and would have a higher level of technology uptake.

5.2.2 Assessment Guideline

The ECAAM model is designed as a self-assessment tool where the statements are opinion of an individual (IT Director/IT Manager) or group of people (IT team, Senior Management Team, IT Project steering committee) with knowledge about the Enterprise Clouds deployment project.

The model assumes that

- Decision to migrate IT services or deploy new Cloud based services has been taken.
- Enterprise should be using either Public Cloud or Hybrid Cloud deployment model.
- Employees/End-users are made aware of the new technology decision through formal organisational communication channels (Email of CEO/Internal Magazine etc.).

ECAAM's survey form allows the respondent to agree or disagree with statement or give yes or no answers, as their opinion on each statement. These statements are the constructs that would assess the readiness in four dimensions.

The assessment should be carried out using the following steps:

1) Form an assessment team to carry out the assessment comprising of IT Management and other Business executives representing organisational units. Participation of IT Leadership in this team is essential, although ECAAM would give score and results even if an individual uses it to assess the organisation.

2) Each team member should be instructed about the purpose of the ECAAM model and its statements. For each statement, a response score based on agreement/disagreement or yes/no should be selected reflecting their personal opinion about the organisation's readiness. This can be done 1) by group consensus approach or 2) by distributing the form and then averaging the score to answer one form or 3) by each member filling a form and combining the data.

3) Readiness score for each of the ECAAM's dimension can be calculated by adding up the score of specific statements identified by code. This total score is then scaled to 10 using maximum score of that dimension. Once the scores are calculated, the total score should then be converted into percentage of the maximum score to reach to a final readiness percentage that is the organisational readiness to adopt Enterprise Clouds. The dimensional scores can be plotted on a radar chart (can be the overall score or even individual scores to see the variances)

4) Review and discuss the overall readiness percentage and dimensional scores. Low scores or actions with low scoring should be discussed in light of what is not being done or possibility of doing those actions to overcome the challenges.

5.2.3 Sample Results and Interpretations

Lets consider an example for sample scoring and discuss its interpretation. Assume that an IT Manager uses ECAAM's form to measure the readiness of Enterprise X for its readiness to overcome adoption challenges. He along with his IT team discusses and scores each statement based on their consensus.

The sample score is tabulated in the table below (See Table 48)

Table 48 ECAAM: Enterprise "X" Sample Assessment

Enterprise Clouds Adoption Assessment Model Scores			
Enterprise "X" Sample Assessment			
IT Leadership and Team			
Sr.	**Dimensions**	**Score***	**Dimensional Score****
1	Technical Readiness	48	**5**
2	IT Capabilities Readiness	36	**5**
3	End-User Readiness	90	**7**
4	Legal & Compliance Readiness	14	**3**
	Total	188	

Overall readiness percentage	**52%**

Note:

** Sample values*

*** Dimensional Score is scaled to 10 and rounded up to next digit*

Maximum Score is 360 in total (6 score for each statement)

Based on opinion of IT Team and Leadership, Enterprise X has obtained score of 48 in technical readiness dimension that would become 5 when scaled to 10. The calculation is done by using this formula: (Dimension Score/Dimension Maximum Score)* 10, figure rounded up to nearest digit thus (48/102)*10 = 4.7058, rounded to 5. Using similar formulae, IT Capabilities Readiness has a score of 36 with dimensional score of 5, End-user Readiness obtained a score of 90 with dimensional score of 7 and in Legal & Compliance dimension the dimensional score is 3. Dimensional score is ranged from 1 to 10 for each dimension, where score below 5 represents poor readiness in that particular dimension. A radar diagram plotting represent the sample values (See Figure 21).

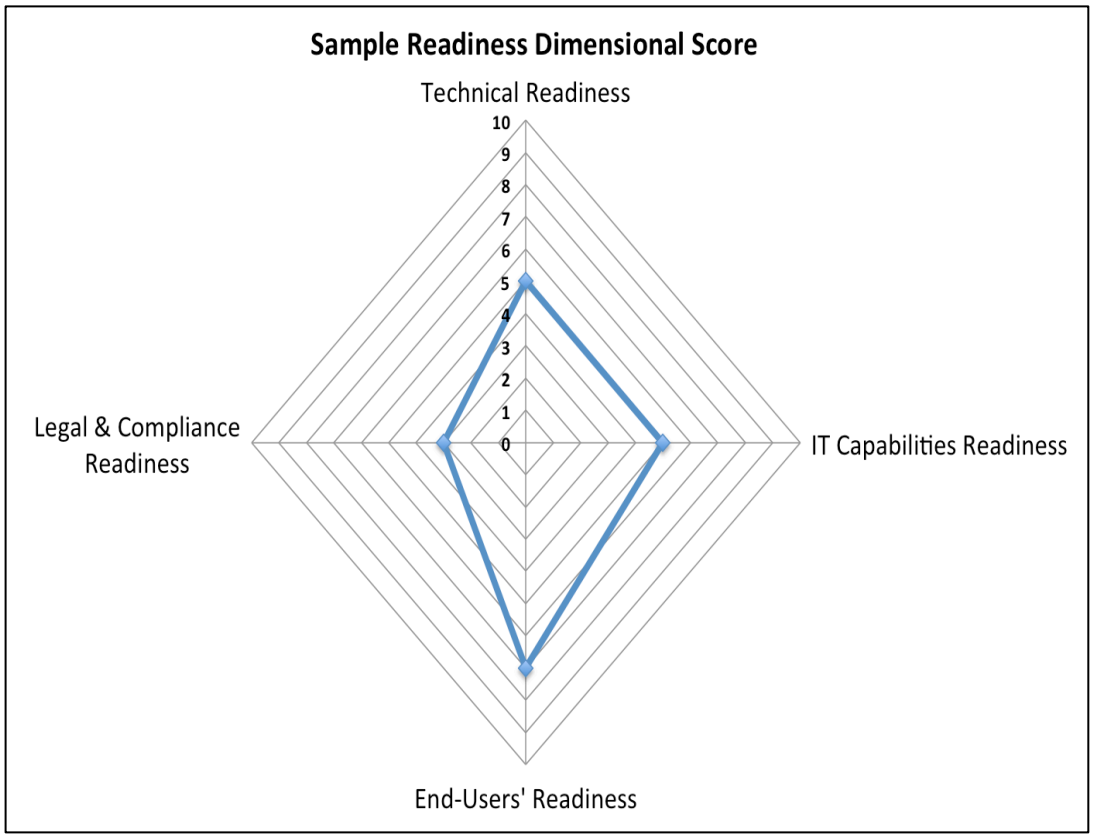

Figure 21 Sample Readiness Dimensional Score

The overall readiness percentage calculates the Enterprise X's readiness as a whole to overcome the adoption challenges. The final score is 188 in all dimensions and that is 52% of maximum score. It is interpreted as that the Enterprise "X" is 52% ready to overcome the challenges that are the barrier in adoption of Enterprise Clouds and with that it has poor readiness to overcome issues in Legal & Compliance and need to focus in that area. Besides this they must discuss individual items where the score is zero or below five. The discussion should focus on the possibility of doing those actions or practices.

5.4 ECAAM's Functional Validity

The last and most import step in model development is assessing the model its self. The model can be judged in in two manners: verification and validation (Thacker et al., 2004).

Verification of the model can be simply done by checking that is it doing what it is intended to do, whereas Validation is the task of showing that model behaves with ample fidelity to satisfy its objectives (Hillston, 2003).

The ECAAM verification was simply carried out by running it several times and measuring its output against sample data. ECAAM's validation however was a task that required careful planning. OITIRS (Snyder-Halpern, 2002) first carried out face validity of the contents and then pilot tested it using focus group. Learning from previous work, two types of validation approaches were applicable on ECAAM, content validation and pilot testing.

The content validity of assessment dimensions and constructs by IT Practitioners, would add more strength to the assessment model as suggested by Snyder & Fields (2006) as an effective approach to improve the assessment model's working and removing ambiguities. Cloud industry experts could be approached to check the model. They could be asked to participate in a focus group session or interviews to evaluate the ECAAM. Interviews are considered more powerful then focus groups where there are multiple items under consideration for qualitative data collection (Morgan, 1996 p10). The data could be analysed and improvement/suggestions could be incorporated into model. Second approach is to pilot test the model in industrial settings, which will validate its assumptions, inputs and behaviour. The aspect of behaviour that needs validation is input values, output values and conclusions (Hillston, 2003).

The pilot testing was chosen as validation methodology due to its obvious strength over content validation, thus ECAAM was pilot-tested in industrial setting in Pakistan. ECAAM model was pilot tested at XSchoolSystems (XSS). XSchoolSystem owns and manages a chain of 32 schools and 3 collages across Pakistan. They are the fifth largest private education provider in Pakistan with a total pupil body of more than 7,500 students registered in their schools and colleges. XSS offers classes from Nursery to High school, Cambridge education from O' levels to A' levels and Pakistani

Secondary & Higher Secondary certificate courses. A team of professionals manages XSS with head office in capital of Pakistan with several regional offices.

The total staff strength of XSS is around 500 employees engaged in teaching and administrative duties in the company. Among these 500, there are 275 people engaged as teaching staff on permanent and visiting basis in school and colleges. Each school has a local administrator, accountant and security staff. Head office runs the managerial departments i.e. Human resource, curriculum development, qualifications, outreach, finance, administration, construction, Information technology, sports etc. Each school's ICT teacher act as ICT Lab in-charge and has 1 IT support staff who maintains the network connectivity and provides IT support. Each college has 1 IT support and 1 network engineer on-site for assistance. The IT department is at placed at Head office with a strength of 8 people, with IT Manager as a team leader, 1 IT Support Manager, 1 Networking Manager, 3 people in Software development team and 2 System administrators managing data center.

The role of IT department is to provide Enterprise IT services to Head office and to other strategic business units. The current IT services being provided are:

- Email to staff members from Xss domain
- Storage/Backup to staff using
- Internet for ICT labs, software for learning and general use
- Managing printer, laptops, tablets, and other ICT related equipment.
- Manage a small Tier 1 level data-centre supporting Microsoft SQL DB and Windows based applications. The data-centre has power back up but no RIAD support is provided.
    - Customised Lecture Management System/Virtual learning System is hosted on on-premises.

  - Customised Curriculum Monitoring System that is accessed by head teachers and principals to update monitoring information is hosted on-premises.
  - Student information System that is integrated with Finance and other systems is hosted on-premises.

- Email hosted on external service provider with annual payment plan for users
- Student Attendance and Access control uses Biometric ID. Every school has biometric devices logging data in centrally hosted application. This application shares child arrival and exit with parents as a text message.
- Website is based on wordpress template and is managing and hosted by external provider.
- LAN installation (cabling, router installations etc.) & maintenance is outsourced.
- XSS is in process of purchasing an ERP by Systems Limited (https://www.systemsltd.com/industries/education). Systems Limited is a leading Microsoft development partner in Pakistan, which has developed a Course Management Systems on Microsoft Dynamics CRM. Due to generous Microsoft policies for underdeveloped countries, all educational institutions get discounted licence fees for Microsoft products and Office365 products and services are free for educational institutions. XSS has availed this option to reduce cost, save cost of hosting email etc.

The futures plan of XSS is to move to a Cloud based email service provider to support email for all staff (teaching and administrative) and students (from grade 5 and above). Besides Email, with influx of company provided devices such as mobile, tablets and laptops to staff, XSS's management plans to provide Cloud based data storage to all staff and student in future. They plan to migrate their applications to Windows Azure Cloud based environment (hosted and offered by Microsoft Cloud services) to get maximum benefit of virtualizations. This would enable them to

windup the on-premise data-center as it is difficult to maintain it in Pakistan. Currently they are facing several difficulties with frequent power breakdowns due to Pakistan's current energy crisis. XSS has engaged Systems Limited as consultant to support application migration, and implementation of Office365 for email and cloud storage services. They chose Office365 for Education services that provides unlimited free email hosting, and Cloud drive storage to every user. Beside that this subscription provides free access to Microsoft Office Products including Office365 to all users within their domain (for student it is valid till they are enrolled).

For a trial of ECAAM, XSS's IT Manager was approached. XSS an organisation fit the bill as they had already decided to migrate their services to Clouds and implementation of the project was underway. Two people in XSS, Director (Admin and Projects) and IT Manager filled the ECAAM forms. Director (Admin & Projects) holds an MBA degree and has an experience of 10 years, with one year in XSS's current job. IT Manager holds a postgraduate degree in Computer Science with almost 4 years of experience of managing IT systems. IT Manager reports to Director (Admin and Projects) as his immediate line-manager.

Both participants were provided separate forms with randomised items. After they had filled in the forms and handed it back, an average score was calculated for their responses and then results were discussed with them. They were asked to provide a feedback on ease of use of the model and its assessment constructs.

The XSS's ECAAM scores are tabulated in the following tables separated into four readiness dimensions for easier readability (See Table 49 page 172,Table 50 page 173,Table 51 page 174,Table 52 page 175,Table 53 page 176).

Table 49 Technical Readiness Assessment Score

Enterprise Clouds Adoption Assessment Model				
Technical Readiness Assessment Score @ XSchoolSystem				
Item Code	**Statements**	**Respondent Score***		
		Director Admin & Projects	**IT Manager**	**Average**
T-01	A pilot deployment was conducted to see operational feasibility	6	6	6
T-02	An assessment of data sensitivity & criticality of work was carried out before Cloud decision	0	0	0
T-03	Network bandwidth requirement assessment based on users, locations and types of IT services was carried out for Cloud services	6	6	6
T-04	Highly interconnected Systems are not migrated on Clouds	6	6	6
T-05	Technical audit was conducted to investigate Clouds and System integration issues for existing applications	0	6	3
T-06	Vendor's reseller/partners would be used to migrate Application/Services on Clouds	6	6	6
T-07	We would use http/https APIs or open source APIs for Cloud services	6	6	6
T-08	Middleware compatible with multiple Clouds would be used to avoid Vendor lock-in risk	0	0	0
T-09	System would be duplicated on a second Cloud service as a stand-by node	0	0	0
T-10	Clouds vendor's performance was investigated before migration for future performance baseline	0	0	0
T-11	Service quality monitoring tools are deployed outside the Cloud for Cloud performance monitoring	0	0	0
T-12	Cloud services performance KPIs are developed/used to monitor quality of Cloud services	0	0	0
T-13	A new feedback mechanism for Cloud service has been provided to end users	0	0	0
T-14	Secure communication protocols and multi-factor authentication are used in accessing Cloud services	0	0	0
T-15	Cloud Vendor's suggestion/guidelines on security and authentication are strictly followed	6	6	6
T-16	Good quality third party/vendor support is available for technical issues in migration of services on Clouds	6	6	6
T-17	We use/subscribe premium support from Cloud vendor	0	0	0
	Total Score	42	48	45

Scoring scale Yes = 6, No = 0, No opinion = 0

Table 50 Legal & Compliance Readiness Assessment Score

Enterprise Clouds Adoption Assessment Model				
Legal & Compliance Readiness Assessment Score @ XSchoolSystem				
Item Code	**Statements**	**Respondent Score**		
		Director Admin & Projects	**IT Manager**	**Average**
L-01	Independent IT/Cloud system audits to test compliance would be held annually	0	0	0
L-02	Information Security policies/procedure are updated for Cloud services Regulatory/Statutory compliance	4	3	3.5
L-03	Cloud vendors are asked to demonstrate compliance with applicable laws & security certifications	0	0	0
L-04	Clouds vendor is asked to use data centers within the required legal jurisdictions.	0	0	0
L-05	Cloud vendor's service agreement are drafted, vetted and approved by Legal department/Lawyers	6	5	5.5
L-06	SLA with Cloud vendor has clauses about data confidentiality & security	5	5	5
L-07	Employees are aware of their legal responsibilities while using Cloud services	2	3	2.5
L-08	User's explicit consent is solicited if the data storage is non-compliant with laws/rules etc.	0	0	0
	Total Score	17	16	16.5

Scoring scale: Strongly disagree 1 to Strongly Agree 6, No opinion = 0

Table 51 IT Capabilities Readiness Assessment Score

Enterprise Clouds Adoption Assessment Model				
IT Capabilities Readiness Assessment Score @ XSchoolSystem				
Item Code	**Statements**	**Respondent Score**		
		Director Admin & Projects	**IT Manager**	**Average**
IC-01	Clouds implementation plan is developed with inputs of current IT staff	6	5	5.5
IC-02	The implementation team have support and resources required for the project.	6	5	5.5
IC-03	Implementation team members would share responsibility for the success of this project	6	5	5.5
IC-04	Current IT Staff are taken as important part of implementation team	6	5	5.5
IC-05	Executives have identified IT processes that would be changed after Clouds and plan to transform them first	4	4	4
IC-06	Vendor Management processes are updated to accommodate Clouds services	0	2	1
IC-07	There is less likelihood of IT staff leaving their jobs because of Clouds services	5	5	5
IC-08	IT staff is given trainings to learn new skills to support Clouds	4	3	3.5
IC-09	Executives have made IT staff aware their new roles and responsibilities after Clouds	6	5	5.5
IC-10	IT staff are given incentive to work with newly changed work patterns	0	0	0
IC-11	There are enough IT staff to meet current support needs.	6	2	4
IC-12	Executives are aware of future staffing needs for supporting Cloud services	6	5	5.5
	Total Score	55	46	50.5

Scoring scale: Strongly disagree 1 to Strongly Agree 6, No opinion = 0

Table 52 End-users' readiness Assessment Score

Enterprise Clouds Adoption Assessment Model				
End users' Readiness Assessment Score @ XSchoolSystem				
Item Code	**Statements**	**Respondent Score**		
		Director Admin & Projects	**IT Manager**	**Average**
EU-01	Vision document detailing Cloud migration goals is shared with all employees	5	4	4.5
EU-02	Staff members are clear about objectives behind migration of IT Services on Clouds	4	3	3.5
EU-03	Staff members always feel free to ask questions and express concerns about IT related issues.	3	2	2.5
EU-04	Employees are kept well informed about IT services thru formal/informal communication channels	1	2	1.5
EU-05	Senior executive is nominated as change champion to engage with employees in dissemination activities related to Clouds	4	3	3.5
EU-06	Staff frequently share their technical knowledge or new technical ideas with others staff members	0	1	0.5
EU-07	Some staff members are willing to try new ideas even if others are reluctant	0	2	1
EU-08	Employees have a positive attitude toward Clouds implementation	3	3	3
EU-09	Employees are provided with online resources to learn on their own pace	4	4	4
EU-10	Multiple hands-on trainings sessions are planned to train staff to use/apply Cloud services in their work	4	3	3.5
EU-11	A survey was conducted from employees asking their preference about type of training they prefer for Clouds	0	0	0
EU-12	Staff training and continuing education are priorities here	5	4	4.5
EU-13	There is an emphasis on the collaborative/interdisciplinary teams to train staff to use Cloud services.	2	2	2
EU-14	Employees are made aware of Cloud vendor's data security capabilities and certifications	1	1	1
EU-15	Employees are aware about data storage location and its transmission across Cloud services	3	2	2.5
EU-16	Employees are aware of IT services on Clouds and impact of any disruptions	4	2	3
EU-17	Employees are clear about data ownership and their responsibilities towards Cloud storage	3	2	2.5

Enterprise Clouds Adoption Assessment Model				
End users' Readiness Assessment Score @ XSchoolSystem				
Item Code	**Statements**	**Respondent Score**		
		Director Admin & Projects	**IT Manager**	**Average**
EU-18	Employees know the maximum tolerable period for disruption of Cloud services and time required for service resumption	2	2	2
EU-19	Policies and procedures for data retention, deletion and storage on Clouds exist and known to all employees	3	2	2.5
EU-20	Employees are encouraged to use encryption for sensitive data stored on Clouds	5	4	4.5
EU-21	Employees are provided with Service quality statistics and performance monitoring data of Cloud services	3	2	2.5
EU-22	Executives have talked with employees about their concerns regarding Cloud services	6	3	4.5
EU-23	IT Executives engage employees in informal meetings to discuss new Cloud services	2	3	2.5
	Total Score	67	56	61.5

Scoring scale: Strongly disagree 1 to Strongly Agree 6, No opinion = 0

Table 53 ECAAM Scores XSchoolSystem

ECAAM Score @ XSchoolSystem								
			Total ECAAM Score			Dimensional Score		
Sr.	Dimensions	Maximum Score	Director	IT Manager	*Average*	Director	IT Manager	*Average*
1	Technical Readiness	102	42	48	***45***	4	5	***5***
2	Legal & Compliance Readiness	72	17	16	***16.5***	2	2	***2***
3	IT Capabilities Readiness	138	55	46	***50.5***	6	5	***5***
4	End Users' Readiness	48	67	56	***61.5***	7	5	***6***
	Total	360	181	166	***173.5***			
Overall readiness percentage			**50%**	**46%**	***48%***			

Dimensional Score is total score scaled to 10 and rounded off.

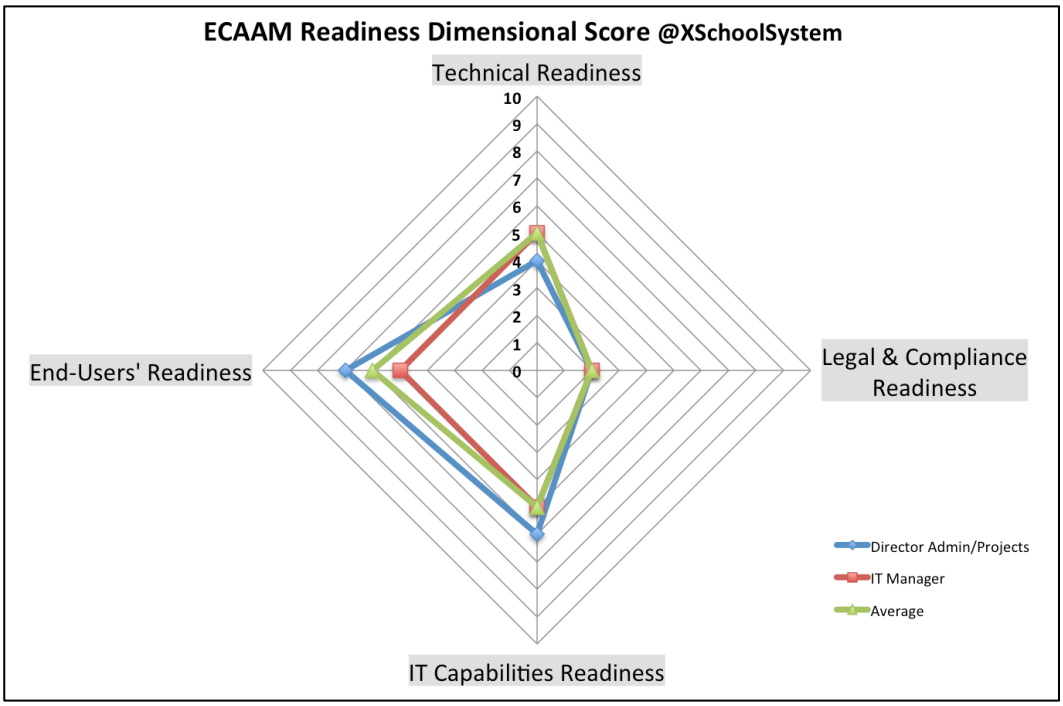

Figure 22 Chart: ECAAM Score XSchoolSystem

The result of ECAAM shows that the overall organisational readiness to adopt Enterprise Clouds is poor and not ready (Average = 48%).

For dimensional scores < 5 is poor, 5-7 is fair and >7 is good level of readiness in that dimension. In technical dimension the score vary by respondents, Director's score is 4, IT Manager's score is 5, but average of both makes a score of 5, thus it can be interpreted that technical readiness is "Fair". The Legal and Compliance readiness score is 2 for all respondents and this is interpreted as "poor" level of readiness. For IT capabilities, the score vary by respondents (See Table 53) but the result is "Fair" level of readiness in this dimension. For End users' readiness the score vary but based on the average score of the respondents the readiness level for this dimension is interpreted as "Fair" level of readiness. The radar chart represents the score by respondents in each dimension (See Figure 22).

After sharing the results with the respondents, an overall discussion on the result was carried out with them. They were asked to review and discuss all the statements with **zero** score and a further analysis was presented to them.

Table 54 IT Manager's Score by Assessment construct themes

ECAAM's Assessment for adoption of Enterprise Clouds@XSchoolSystems			
IT Manager's Score by Assessment construct themes			
Sr.	**Readiness Dimensions**	**Construct Theme**	**IT Manager's Score****
1	Technical	Conducting Technical Assessments	4
2		Managing existing application migration	6
3		Mitigating Lock-in risk	2
4		Monitoring Clouds QoS	0
5		Implementing Cloud specific Security	3
6		Using vendor's technical support	3
7	Legal/Compliance	Ensuring compliance with rules	1
8		Pursuing Legal coverage	3.33
9		Creating Employee awareness on legal issues	1.5
10	IT Capabilities	Creating Cloud Implementation support	5
11		Changing processes	3
12		Mitigating IT capabilities loss risk	3.25
13		Managing IT Staffing	3.5
14	End users	Communicating with Employees	2.8
15		Employee adaptability	2
16		Providing training to Employees	2.6
17		Creating awareness about Cloud services	1.8
18		Addressing Employee Concerns	2.8

Technical readiness scoring Maximum 6 and Minimum 0, where as for other readiness dimensional score Maximum = 6 and minimum = 1

*** Average value of score by Assessment Constructs' theme i.e. Theme: "Conducting Technical Assessments" has three constructs T-01, T-02, T-03*

ECAAM suggests assessor to discuss all statements where score is zero or below 3 as this would indicate that either the respondent has no idea or has no opinion of this practice and its impact. The low scoring is an indicator that these actions should be taken or should be applied in some form to help the Enterprise in adoption of Enterprise Cloud services.

Note the tabulation in above table (See Table 54); it presents the IT Manager's score tabulate by construct themes. The score is calculated by averaging the statement score under that theme (i.e. IT Manager scored item T-01 as 6, T-02 as 0 and T-03 as 6, so average score is 4 here in the above table, refer to Table 49). This score can be used to see what actions/practices are not being taken within that particular dimension.

In Technical readiness, “Monitoring Clouds QoS” is scored as zero, indicating that no action similar in nature or close to it is being carried out to monitor Clouds QoS. Looking at the table, “Mitigating Lock-in risk” is scored at 2 indicating poor readiness to mitigate lock-in risk and by doing the actions such as using http/https based APIs and middleware for accessing Clouds can help Enterprise in mitigating lock-in risk and improve their readiness to overcome the challenges associated with vendor/service lock-in. On a similar note, “ensuring compliance with rules” is scored at 1 and “creating employee awareness” is scored at 1.5, indicating that IT Manager/Decision makers need to develop awareness about compliance rules for Clouds services that are not being adhered to. A discussion on these factors would bring clarity to ECAAM results as perhaps there are no rules to be complied with in an operational environment (as Pakistan has no laws that governs Clouds/Data protection, a cyber crime law was recently passed by Pakistani government). The scoring in IT Capabilities dimension is in a range of 3 to 5 that shows that generally readiness level is “fair” and little focus is required to implement some actions. Whereas in End-users’ readiness dimension the lowest score is of “Creating awareness about Cloud services” that is 1.8. This is indicative that there is a need to work in creating more awareness about Cloud in organisation. Lack of information about technology makes people resist its usage in their work (Oliveira & Martins, 2010).

XSS staff was requested to provide their feedback on ECAAM as a tool to measure organisational readiness for Clouds and it’s working. Their general opinion was that the tool is relevant, easy to use and helpful and gave them information. They suggested provision of an automated tool and further enquired about actions to increase Employee adaptability.

After the pilot testing it was concluded that the ECAAM model is behaving as desired, with need of minor improvements: removing ambiguities and explanations of results. The suggestions were later incorporated.

5.5 Comparing ECAAM with existing models

Enterprise Clouds Adoption Assessment Model (ECAAM) is compared with three-assessment models reviewed in Chapter 2. The three models are Organizational Information Technology Innovation Readiness Scale (OITIRS) (Snyder-Halpern, 2002), Electronics Health Records - Organizational Readiness Tool (EHR-ORT) (Cherry & Owen, 2008) and Texas Christian University - Organizational Readiness to Change Assessment (TCU-ORCA) (Lehman, Joe & Simpson, 2002).

The comparison of ECAAM and these models are done on points, discussed below. Following table (See Table 55) presents this comparison.

- The aim of the model and what does it measures: ECAAM differs slightly from OITIRS, TCU-ORCA and EHR-ORT, but all four model have a commonality that all are based on innovation assessment as its foundation.
- Assessment methodology: How is assessment performed? OITIRS, TCU-ORCA and EHR-ORT tools are aimed at administration to the whole organisation whereas ECAAM is aimed at IT leadership. ECAAM can be filled by an individual or can work with groups consensus too.
- Items scale: OITIRS, TCU-ORCA and EHR-ORT tools using Likert type agreement scale with score ranging from 1 to 7 or 1 to 5, whereas ECAAM using Likert type scale and binary yes/no answer response.
- Results & Interpretation: OITIRS and EHR-ORT both have similar results as they give a value as percentage of readiness. The interpretation of their results too has similarities. The weakness is that their results cannot be compared to their corresponding areas measured. The results and interpretation of TCU-ORCA are unique as it focuses in the areas it measure and not gives an over all figure or score. This helps in to focus on areas with lower or poor scoring. Learning for all three models: OITIRS, TCU-ORCA and EHR-ORT, ECAAM has an hybrid approach where individual dimension assessment score and a total/overall score is calculated with separate interpretations are provided.

Table 55 Comparing ECAAM with other models

Comparing ECAAM with other organisational assessment models				
Assessment Model & Abbreviation	**Organizational Information Technology Innovation Readiness (OITIRS) (Snyder-Halpern, 2001)**	**Electronics Health Records - Organizational Readiness Tool for Licensed Nursing Facilities (EHR-ORT) (Cherry & Owen, 2008)**	**Texas Christian University - Organisational Readiness to Change Assessment (TCU-ORCA) (Lehman, Joe & Simpson, 2002)**	**Enterprise Clouds Adoption Assessment Model (ECAAM)**
Aim	To measure organisational readiness to use IT innovation	To measure licensed nursing facility's successful implementation of Electronic Health Records	To measure organisational readiness to change to implement new technology	To measure organisational readiness to overcome the challenges in adoption of Enterprise Clouds services
Measures	Measures organisational readiness to assess readiness for Information Technology Innovation in organisational dimensions The dimensions are: - Resources - End-Users - Technology - Knowledge - Processes - Values & Goals - Management Structures - Administrative Support	Measures organisational readiness in functional areas. The areas are: - Organisational culture - Human factors - Financial aspects - Implementation processes - Staff training - Evidence that systems will improve care - State regulatory support - Technical requirements	Measures organisational change readiness in four areas The areas are: - Motivation for change - Institutional resources - Personality attributes of the staff - Organisational climate	Measures organisational readiness to overcome adoption challenges The dimensions are: - Technical - IT Capabilities - End-users - Legal & Compliance
Assessment methodology	Survey form administration to all employees	Survey form administration to all employees	Survey form to administered all employees. Wordings varying according job nature	Survey form to assessment team or individual IT Leader
Items & Scale	48 Items, Likert-type response format 1 (strongly disagree) to 7 (strongly agree) OITIRS score: Sum of all 48 items	20 Items, Likert-type response format 1 (strongly disagree) to 7 (strongly agree) EHR-ORT Score: Sum of all 20 items	115 Items, Likert-type items 1 (strongly disagree) to 5 (strongly agree) TCU-ORC has no single score	60 Items, Likert-type agreement or disagreement, Yes/No response 1 (strongly disagree) to 6 (strongly agree), 0 (No) or 6 (Yes) ECAAM: Readiness percentage, Dimensional score scaled to 10

Comparing ECAAM with other organisational assessment models				
Assessment Model & Abbreviation	**Organizational Information Technology Innovation Readiness (OITIRS) (Snyder-Halpern, 2001)**	**Electronics Health Records - Organizational Readiness Tool for Licensed Nursing Facilities (EHR-ORT) (Cherry & Owen, 2008)**	**Texas Christian University - Organisational Readiness to Change Assessment (TCU-ORCA) (Lehman, Joe & Simpson, 2002)**	**Enterprise Clouds Adoption Assessment Model (ECAAM)**
Results & Interpretation	Higher the score greater the perception of organisational readiness to support IT innovation	Higher the score greater the perception of organisational readiness to support implementation of EHR	Each areas is discussed with percentage of item response to identify barriers to change	Percentage to overcome adoption challenges, Each dimension has dimensional score scaled to 10, below 5 is poor readiness, 5-7 fair and above 7 is good readiness
Development Approach	Identified dimensions and indicators from literature Conducted a Delphi study to validate dimensions and indicators Developed OITIRS Scale	Conducted a SLR to identify factors Conducted focus group session with IT Experts to validated and identify factors Developed EHR-ORT	Identified barriers to change readiness from literature Developed TUC-ORC	Conducted a SLR to identify challenges that are barrier in adoption of Enterprise Clouds Carried out a survey research to validate the challenges from IT experts and sought practices to overcome challenges Developed ECAAM
ECAAM's commonalities with the model	Similar organisational dimensional approach Some dimensions have common definition i.e. Technical, End-users Some items overlap in definition,	Development approach is similar	Some of the items in ECAAM are adapted from this model	

Comparing ECAAM with other organisational assessment models				
Assessment Model & Abbreviation	**Organizational Information Technology Innovation Readiness (OITIRS) (Snyder-Halpern, 2001)**	**Electronics Health Records - Organizational Readiness Tool for Licensed Nursing Facilities (EHR-ORT) (Cherry & Owen, 2008)**	**Texas Christian University - Organisational Readiness to Change Assessment (TCU-ORCA) (Lehman, Joe & Simpson, 2002)**	**Enterprise Clouds Adoption Assessment Model (ECAAM)**
Weaknesses	- Some of the Items are specific to health care settings - Based on user's perception of readiness - Ignores External and organisational characteristics	- Specific to Electronic Health Record as technology in healthcare setting - Items are technology and healthcare setting specific Considers financial support as an area but not necessary everyone has access to information Based on user's perception of readiness	Focused on Change readiness Items and sub areas are focused on healthcare setting Results needs analytical skills to draw a conclusion Focus is perception, resources and a actions towards change readiness of organisation, Compare groups based on job nature to report it output	Technology specific Focused on industry preferred set of practices Based on of Manager response of existence of a practice or doing an action for implementation, Manager can lie, hide or deceive while answering

The comparison of the ECAAM model, showed some weakness in ECAAM

ECAAM used self-reported information to give out its interpretation and conclusion. IT Manager responding to ECAAM can give false answer for any reason. There is no check in ECAAM or any other way to carry out input validation. However, as with any self –reported data, lying would fail the aim of using the model.

ECAAM is specific to Enterprise Clouds (Public Clouds or Hybrid Clouds only) and it cannot be used to assess adoption of any other technology. This would invalidate the output and assessment constructs of the model.

5.5 Chapter Summary

The proposed solution to the problem is the Enterprise Clouds Adoption Assessment Model (ECAAM) model. This model is developed from two inputs, the key adoption challenges identified from literature and validated by IT practitioners and the industry-preferred practices that can overcome the challenges.

This model assesses an organisation's readiness in four dimensions to measure its readiness to overcome the adoption challenges for a successful *organisational adoption* of newly deployed/migrated IT services on Enterprise Clouds. In the technical readiness dimension the assessment emphasis is placed on performing bringing readiness in 6 areas related to Cloud technology implementation; the areas are: conducting technical assessment, managing existing application migration, mitigating vendor lock-in risk, monitoring Clouds' Quality of Service (QoS), implementing Clouds specific security and using vendor's support. For assessing the Legal & Compliance Readiness dimension, 8 constructs are added to the ECAAM where the themes of the constructs are: ensuring compliance with rules, pursuing Legal coverage and creating employee awareness on legal issues. To assess IT capabilities that measure readiness in IT people and IT processes the constructs have four themes: creating Cloud implementation support, changing the processes, mitigating loss of IT capabilities risk and managing the IT staffing. End user readiness is focused on assessing readiness in End users of the Cloud services. This dimension has the largest number of assessment constructs with five themes: communicating with employees, employee adaptability, providing training to employees, creating awareness about Cloud services and addressing employee concerns.

The ECAAM was pilot tested in industrial settings as that helped in the evaluating organisation to identify the lack of practices and effectiveness of their strategy to implement Enterprise Clouds.

Chapter 6: Conclusion

6.1 Conclusion

In the end I would like to summarise thesis findings, suggest further work and discuss implications of this work on research and practice.

The research study started out to propose a model that can assess an organisation's readiness to overcome the challenges in adoption of Enterprise Clouds. The model's foundation would be the challenges and the practices; both are two discrete sets of facts ascertained from two different data sources.

The first one was the challenges in the adoption of Enterprise Clouds. Firstly, to identify the challenges an SLR was conducted on literature. The outcomes of SLR were the key concerns and issues reported in literature that deter using or implementing/adopting Cloud technology in Enterprise environments. The results highlighted security and reliability concerns, lack of compliance, vendor lock-in issues, data privacy and difficulties in application and service migration as key challenges in the adoption of the Clouds. Several weaknesses and modest empirical strength was observed in resulting data set.

The second data set was the tacit knowledge of IT practitioners of their practices and actions that can overcome challenges in the adoption of Enterprise Clouds. Some of the preferred industrial practices are: using open source APIs to access Cloud services, involvement of legal team in vendor selection process, identification of the workflows/processes to change, involvement of senior executive as change champion, using Re-seller/Vendor partners support for application/service migration to Clouds, developing new Cloud service quality feedback mechanism etc. Survey research was also used to collect the IT practitioner's views on the adoption challenges from their experience in deploying Cloud services, validating the concerns and issues identified thru SLR.

A model was developed based on the practices suggest by IT practitioners and other suggested practices. It was ensured that model addresses all identified key adoption challenges, is easy to use and gives interpretable results. The model is referred as Enterprise Clouds Adoption Assessment Model (ECAAM) that assesses an organisation's readiness in four dimensions (Technical,

IT capabilities, Legal & Compliance and End-users readiness) to overcome the adoption challenges for a successful adoption of Enterprise Clouds. ECAAM was pilot-tested in industrial settings for its validation.

The study's objective was to identify the issues, concerns and barriers in the adoption of Enterprise Clouds. The research question (RQ1) was answered by reviewing the literature, surveying the perceptions about them with the Cloud experts' community and then reaching to the 15 key challenges in the adoption of Enterprise Clouds. The initial literature search pointed out that several studies talked of issues inherent with technology, but the SLR study ensured that only those issues become part of the results (key challenges) that are barrier in the adoption of the Cloud services. Research in regard to technology adoption and organisational diffusion seconds the view that an issue with context to organisational size can be and should be taken separately (Oliveira & Martins, 2010; Oliveira & Martins, 2011). Second objective, was to propose the model (the solution). The develop approach was to build a model that can measure the existence of capabilities to overcome the barrier to adoption of technology. It was suggested in prior research that industrial practices help in increasing capabilities, thus industrial practices were collect by a survey research that that targeted people with deployment experience. The model's working, its assessment constructs, item scales, scoring and results interpretation are adapted from previously established models of readiness measurement with newly developed assessment constructs specific to Cloud adoption.

The initial research plan was to conduct the SLR to collect empirical evidence of the challenges and then seek interviews from IT Experts, to discuss the implication and background of the challenge in their organisation and ask about their practices. The SLR results identified 80 challenges from the set of SLR results of 25 papers. The application of thematic analysis and synthesis (Cruzes & Dybå, 2011b) on the SLR data, which was relatively new technique for SLR in year 2011, helped in reaching towards 27 key challenges reported in reviewed literature. These 27 challenges were grouped using thematic synthesis based on their context from source. This helped in drawing up challenges into five themes that represented three issues and two concerns (Refer to Chapter 3). The lack of empirical data (discussed in Chapter 2 and 3) forced significant change in research strategy from conducting interviews to conducting a survey research.

There were some interested findings in the data. There was significant disagreement in the data reported in literature and views of the IT practitioners. Interoperability as a challenge have been reported in multiple studies as a barrier in adoption in year 2010 but not this was not agreed by a larger number of IT practitioners in year 2014. This is due to advancement in technologies that help in overcoming interoperability issues between Clouds.

Issues as End-users' resistance to change was reported in almost all the literature reviewed but two issues i.e. IT staff's change and change in work patters were reported in only few studies. The source for these challenges was seminal work in Enterprise Clouds of Khajeh-Hosseini, Greenwood & Sommerville (2010). These two reported challenges were not significant in early 2010 but in IT practitioners' perception, they have high significance as a barrier to adoption of Clouds.

In last, the ECAAM's strength in comparison to other model is evident as it tackles multifaceted organisational issues. Another strength is that this models segregates people into two-groups end-users and IT staff which is usually grouped under one term "employee". People resist change but for different reasons, thus the practices to overcome resistance to change cannot be the same. The assessment constructs developed in ECAAM addresses them separately. Ignoring IT staff's concerns can be disastrous in deployment of Enterprise Clouds.

Strength of ECAAM lies in its dimensional segregation of it scoring items as well. Dimensional segmentation and it's scoring, gives a better understanding to the evaluator about specific areas of concern that can be prioritised.

Cloud Computing as a technology is not fundamentally new yet the End users' concerns related to it make it seem like new and immature technology that is feared. In a private conversation, a Cloud guru suggested, "the best way to overcome End-users' concerns is not to tell them that service is delivered using Clouds". This would be the anti-thesis of this study. It is firm belief here, that concerns should be addressed rather than hiding or ignoring.

The future of modern day organisation is moving towards Big Data and Internet of Things that would be generating more data, cloud bursting would be the most suitable option in this regard.

6.2 Further Work

This work does not stop here as it can be further expanded to measure impact of ECAAM on an organisation. A case study could be designed to observe two case subjects, where one has used ECAAM to evaluate the organisation, compared with another subject that has not used ECAAM during implementation. Both subjects could be compared at different intervals (start of the project and after six months and after roll out of the project) using an technology assimilation measurement tool suggested in literature i.e. (Kouki, Poulin & Pellerin, 2009; Gao et al., 2016). This longitudinal study would show impact of ECAAM's measurement and its suggested practices in increasing the organisational adoption of Enterprise Clouds.

6.3 Implication for Research and Practices

For the research community this work adds to the Cloud Computing body of knowledge in two major aspects. This work has explored and identified the issues and concerns that are barrier in adoption of Cloud services. It is suggested to further explore the organisational and security concerns, as they tend to be more significant in large-scale organisations and would have more impact. The future of Cloud Computing and other services would be creating more security concerns. The application of Internet of Things devices and bring your own device (BYOD) policies in organisations in future would create more security concerns.

The set of industrial practices identified by this work at this stage are promising practices, which have worked in solving issue in one organisation and can be replicated in similar situations. It is suggested that this work can be used as an impetus to explore more practices identifying exploring more diverse group of Cloud experts and enhance the set of industry-preferred practices. Future research strategies can work to gather more practices that can be further investigated and evaluated for their impact.

ECAAM can be improved by adding more assessment constructs. If future, any researcher can add more assessment constructs or more dimension based on newly identified research. Addition of more assessment constructs would not alter the over all model's structure.

For the IT practitioner community, the ECAAM is first Cloud technology specific model and can help them in evaluating organisational readiness to adopt Clouds. The model's independence from adoption methodology and it Vendor neutral approach can be used to measure any Cloud service deployment initiative/project within their organisation.

As an IT Leader, the results of ECAAM model can be used to

- learn about the key challenges that are barrier in the adoption of Clouds and the practices that help in overcoming them The readiness dimension inform the evaluator to analyse his/her organisation and place an importance to brining readiness to adopt the newly introduce Cloud services.
- guide implementation team to follow specific practices that help in overcoming key issues and concerns, follow practices such as team integration and staff training etc. as part of implementation project.
- guide corporate communications/Internal marketing team in making the communication plan to support the dissemination activities. This plan's is essential in addressing Employee's concerns and overcoming resistance to change. IT capabilities readiness, End users readiness and some items of Legal & Compliance Readiness can also guide the communication plan. If the change management team is not part of corporate communications and work as an independent team then this should be shared with them too. Communication plan is also part of change management plan. It can help in making change plan more effective by addressing concerns of End user and IT staff avoiding the resistance and employee turn-over.
- guide the higher management about organisation readiness for the adoption of Clouds and their own role in IT capabilities readiness and End users readiness.
- measure and develop a baseline and then re-measure to judge the impact of the practices in increasing the readiness level.

The IT practitioner community would be able to contribute back to model's future versioning by providing suggestion. The possibility of future versions would help them in continually monitor the organisational readiness level associated with Cloud technology.

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Annexures

Annexure A: SLR Result Papers

SLR Result Papers			
Sr.	**Paper ID**	**Citation**	**Reference**
1	Paper01	(Kim et al., 2009)	KIM, W., KIM, S. D., LEE, E. & LEE, S. 2009. Adoption issues for Cloud Computing. *11th International Conference on Information Integration and Web-based Applications Services.* Kuala Lumpur, Malaysia: ACM.
2	Paper02	(Armbrust et al., 2010)	ARMBRUST, M., FOX, A., GRIFFITH, R., JOSEPH, A. D., KATZ, R., KONWINSKI, A., LEE, G., PATTERSON, D., RABKIN, A., STOICA, I. & ZAHARIA, M. 2010. A view of Cloud Computing. *Communications of the ACM,* 53**,** 50-58.
3	Paper03	(Luoma and Nyberg, 2011)	LUOMA, E. & NYBERG, T. 2011. Four scenarios for adoption of Cloud Computing in China. *ECIS 2011.*
4	Paper04	(Nuseibeh, 2011)	NUSEIBEH, H. 2011. Adoption of Cloud Computing in Organizations. *AMCIS 2011.*
5	Paper05	(Sarkar and Young, 2011)	SARKAR, P. & YOUNG, L. 2011. Sailing the Cloud: A Case Study of perceptions and changing roles in an Australian University. *ECIS 2011.*
6	Paper06	(Janssen and Joha, 2011)	JANSSEN, M. & JOHA, A. 2011. Challenges for adopting Cloud-based Software as a Service (SaaS) in the Public sector. *ECIS 2011.*
7	Paper07	(Simalango et al., 2010)	SIMALANGO, M. F., KANG, M.-Y. & OH, S. 2010. Towards Constraint-based High Performance Cloud System in the Process of Cloud Computing Adoption in an Organization. *http://arxiv.org/abs/1010.4952v1* [Online].
8	Paper08	(Bisong and Rahman, 2011)	BISONG, A. & RAHMAN, S. M. 2011. An overview of the security concerns in Enterprise Cloud Computing. *International Journal of Network Security & its Applications (IJNSA),* 3.
9	Paper09	(Greenwood et al., 2010)	GREENWOOD, D., KHAJEH-HOSSEINI, A., SMITH, J. W. & SOMMERVILLE, I. 2010. The Cloud Adoption Toolkit: Addressing the Challenges of Cloud Adoption in Enterprise. Available: http://arxiv.org/abs/1003.3866.
10	Paper10	(Qamar et al., 2010)	QAMAR, S., LAL, N. & SINGH, M. 2010. Internet ware Cloud Computing: Challenges. *http://arxiv.org/abs/1004.1746* [Online].
11	Paper11	(Khajeh-Hosseini, Sommerville & Sriram, 2010)	KHAJEH-HOSSEINI, A., SOMMERVILLE, I. & SRIRAM, I. 2010c. Research Challenges for Enterprise Cloud Computing. http://arxiv.org/abs/1001.3257 [Online].
12	Paper12	(Farrell, 2009)	FARRELL, R. 2009. Securing the Cloud-Governance, Risk, and Compliance Issues Reign Supreme. *Information Security Journal: A Global Perspective,* 19**,** 310-319.
13	Paper13	(Antonopoulos et al., 2010)	ANTONOPOULOS, N., GILLAM, L., GAGLIARDI, F. & MUSCELLA, S. 2010. Cloud Computing – Data Confidentiality and Interoperability Challenges. *Cloud Computing.* Springer London.

SLR Result Papers			
Sr.	**Paper ID**	**Citation**	**Reference**
14	Paper14	(Neal, 2009)	NEAL, L. 2009. Is Cloud Computing Really Ready for Prime Time? *Computer,* 42**,** 15-20.
15	Paper15	(Chinyao et al., 2011)	CHINYAO, L., YAHSUEH, C. & MINGCHANG, W. 2011. Understanding the determinants of Cloud Computing adoption. *Industrial Management & Data Systems,* 111**,** 1006-1023.
16	Paper16	(Dawoud et al., 2010)	DAWOUD, W., TAKOUNA, I. & MEINEL, C. Infrastructure as a service security: Challenges and solutions. The 7th International Conference on Informatics and Systems (INFOS), 2010, 28-30 March 2010 2010. 1-8.
17	Paper17	(Dillon et al., 2010)	DILLON, T., CHEN, W. & CHANG, E. Cloud Computing: Issues and Challenges. 24th IEEE International Conference on Advanced Information Networking and Applications (AINA), 20-23 April 2010 2010. IEEE, 27-33.
18	Paper18	(Gupta, 2010)	GUPTA, A. Cloud computing growing interest and related concerns. 2nd International Conference on Computer Technology and Development (ICCTD), 2010, 2-4 Nov. 2010 2010. IEEE, 462-465.
19	Paper19	(Khajeh-Hosseini, Greenwood & Sommerville, 2010)	KHAJEH-HOSSEINI, A., GREENWOOD, D. & SOMMERVILLE, I. Cloud Migration: A Case Study of Migrating an Enterprise IT System to IaaS. 3rd International Conference on Cloud Computing, 5-10 July 2010 **2010b**. IEEE, 450-457.
20	Paper20	(Benlian & Hess, 2011)	BENLIAN, A. & HESS, T. 2011. Opportunities and risks of software-as-a-service: Findings from a survey of IT executives. *Decision Support Systems,* 52**,** 232-246.
21	Paper21	(Marston et al., 2010)	MARSTON, S., LI, Z., BANDYOPADHYAY, S., ZHANG, J. & GHALSASI, A. 2010. Cloud Computing - The business perspective. *Decision Support Systems,* 51**,** 176-189.
22	Paper22	(Paquette et al., 2010)	PAQUETTE, S., JAEGER, P. T. & WILSON, S. C. 2010. Identifying the security risks associated with governmental use of cloud computing. *Government Information Quarterly,* 27**,** 245-253.
23	Paper23	(Subashini and Kavitha, 2010)	SUBASHINI, S. & KAVITHA, V. 2010. A survey on security issues in service delivery models of Cloud Computing. *Journal of Network and Computer Applications,* 34**,** 1-11.
24	Paper24	(Sultan, 2010)	SULTAN, N. 2010. Cloud computing for education: A new dawn? *International Journal of Information Management,* 30**,** 109-116.
25	Paper25	(Wu, 2011)	WU, W.-W. 2011. Mining significant factors affecting the adoption of SaaS using the rough set approach. *Journal of Systems and Software,* 84**,** 435-441.

Annexure B: Data Codification and Labelling

Data Codification and Labelling				
Challenges in adoption of Cloud Computing				
Higher-order Theme	Theme	Concept	Challenge (Quote)	Frequency
Issues	Technical Issues	Cloud Implementation issues	Lock-in issues (Data, Services, Vendor)	9
			Difficulties in migration of current application/services	7
			Cloud Vendor/Services Interoperability	7
			Re-engineering of legacy application	3
			Lack of migration support from vendors	3
			Cost of software requirement change	1
			Issues in migrating from Private to Public/Hybrid Cloud	1
			Lack of transitional Strategy	1
			What/Which applications should go to Clouds?	1
		IT Infrastructure Issues	Non-existence of compatible IT resources within organization	4
			Poor internet connection	2
			Non adoption to Server Virtualization	1
		IT Service issues	Increased operational cost	4
			Loss of control over resources	4
			Degraded Service quality (after adoption of Clouds)	4
			Lack of QOS/SLA monitoring solutions	3
			Trade-offs on computation/communication	2
			Deterioration of customer care & service quality	1
Issues	Organisational Issues	Business Case issues	Operational costs of using private/public cloud is difficult to calculate	2
			Concerns / Perception of hidden Cloud usage costs	2
			Cloud not fit for Business	2
			Uncertainty of Cloud technology/new technology	2
			Decision to adopt Public or Private Cloud	2
			Cost Benefit Analysis is complicated	1
			Poor economic incentives in lieu of organisational change	1
			Decision Long-term/Short-term SLA	1

Data Codification and Labelling				
Challenges in adoption of Cloud Computing				
Higher-order Theme	Theme	Concept	Challenge (Quote)	Frequency
			Influences of internal/external parties on the adoption decision process	1
		End-User issues	End user's resistance to change	3
			End users lacks an understanding of the Cloud	2
Issues	Organisational Issues	IT Staff issues	IT Staff's resistance to change	3
			Loss of internal expertise (IT Capabilities)	3
			IT Staff lacks technical expertise/capacity to integrate	2
			Decrease of satisfying work for IT Staff	1
			Insufficient expertise in making/drafting SLA	1
			IT's Departmental downsizing	1
			Change in IT Dept.'s role/authority	5
			Changed IT organisational work patterns	3
	Organisational Issues	Organisational Change	Change in the work of various system stakeholders	2
			Fear of organisational change	2
			Cost of Process Change	1
			Organisation change will effect legacy system	1
Issues			Significance and extent of organisational change	1
		Organisational Issues	Client's organisational readiness	3
			Lack of Top management support for adoption of Cloud Computing	2
			Organisation's characteristics and competitive strategies	1
	Organisational Issues	Vendor management issues	Increased dependence on external 3rd party	5
			No liability for failure(s)/ blame for failure	4
			Lack of performance guarantees from Cloud Vendor	2
		Vendor selection issues	Cloud Vendor's long term viability/sustainability	5
Issues			Lack of client's right to audit vendor services/ Auditability	3
			Cloud services billing are non-transparent/complicated	1
			Lack of SLA Analysis framework	1
			Non-uniformity of SLA	1
			Not enough major Cloud players	1

Data Codification and Labelling				
Challenges in adoption of Cloud Computing				
Higher-order Theme	Theme	Concept	Challenge (Quote)	Frequency
	Environmental issues	Legal & Compliance issues	Legal/Compliance issues in using/adopting Cloud Computing	11
			Lack of compliance with European Data Protection Directives	2
Higher-order Theme	Theme	Concept	Challenge (Quote)	Frequency
Concerns	Data & Services related concerns	Availability Concerns	Cloud Vendor's availability	7
			Cloud Vendor's failures	4
			Cloud Technology it self is a single-point of failure	1
		Data privacy concerns	Data Privacy/Confidentiality Concerns	9
			Data's privacy after termination of SLA	2
		Data related concerns	Data integrity concerns	5
			Data Loss/Leakage	4
			Data's status after change of SLA	1
			Client's does not know where data resides	1
		Reliability Concerns	Reliability concerns on Cloud Computing	13
			Lack of trust on Cloud Vendor	1
Concerns	Security Concerns	Client's security concerns	Security concerns/apprehension about Cloud Computing	15
			Client exposure to malicious resources	2
			Client's account or service or traffic hijacking	1
			Client's staff's misuse of Cloud Computing	1
			Concerns about need to add more IT security	1
			Protecting the cloud user against the provider.	1
	Security Concerns	Security Concerns - Vendor Related	Cloud Vendor's vulnerability to attacks	4
			Insecure Cloud access/usage API	2
			Physical /Cyber attacks on Cloud vendor	2
			Cloud vendor's mechanism for data/user privacy	1
			Concern of reputation loss ("reputation fate-sharing")	1
			Malicious insiders at Cloud Vendor	1
			Virtualization's vulnerabilities	1

Annexure C: Survey Respondent's Profiles

Questionnaire survey respondent profiles							
Sr.	**Respondent ID**	**Respondent Group**	**Job Title/Role**	**Experience in Current job/role**	**Type of Organisation**	**Year of Cloud service Deployment in Organisation**	**Workstations in Organisation**
1	Respondent01	Group B	IT Manager	3-5 yrs			
2	Respondent02	Group B	IT Manager	1-3 yrs			
3	Respondent04	Group A	IT Support	1-3 yrs	Higher Education Institution	2012	100-500
4	Respondent05	Group A	***Head of Computing and IT***	> 5 years	Further Educational Institution	2007	100-500
5	Respondent06	Group A	ICT Teacher	1-3 yrs	Secondary School	2012	100-500
6	Respondent07	Group B	IT Manager	3-5 yrs			
7	Respondent08	Group B	No Answer	> 5 years			
8	Respondent09	Group A	Systems Administrator	> 5 years	University	2012	> 500
9	Respondent10	Group B	***Business Analyst***	3-5 yrs			
10	Respondent11	Group A	IT Support	3-5 yrs	Higher Education Institution	2012	100-500
11	Respondent12	Group B	IT Consultant	1-3 yrs			
12	Respondent13	Group A	IT Manager	3-5 yrs	University	2010	> 500
13	Respondent14	Group A	No Answer	< 1 yr	University	2011	100-500
14	Respondent17	Group B	IT Consultant	1-3 yrs			
15	Respondent18	Group B	CEO	> 5 years			
16	Respondent19	Group A	Implementation Manager	> 5 years	University	2011	> 500
17	Respondent20	Group A	IT Manager	< 1 yr	University	2011	> 500
18	Respondent21	Group B	IT Consultant	3-5 yrs			
19	Respondent22	Group B	IT Consultant	3-5 yrs			
20	Respondent23	Group B	IT Director	> 5 years			
21	Respondent24	Group A	Systems Administrator	3-5 yrs	University	2012	> 500
22	Respondent26	Group B	IT Manager	< 1 yr			
23	Respondent30	Group A	IT Support	3-5 yrs	Higher Education Institution	2012	100-500
24	Respondent31	Group B	No Answer	3-5 yrs			
25	Respondent32	Group B	No Answer	3-5 yrs			
26	Respondent33	Group B	IT Consultant	< 1 yr			
27	Respondent34	Group A	Systems Administrator	1-3 yrs	University	2011	> 500
28	Respondent37	Group B	IT Consultant	1-3 yrs			
29	Respondent39	Group B	***Network Analyst***	1-3 yrs			
30	Respondent41	Group B	IT Consultant	> 5 years			
31	Respondent44	Group A	No Answer	< 1 yr	University	2012	> 500
32	Respondent53	Group A	IT Manager	1-3 yrs	University	2012	> 500
33	Respondent56	Group A	IT Manager	1-3 yrs	University	2012	> 500

Questionnaire survey respondent profiles							
Sr.	**Respondent ID**	**Respondent Group**	**Job Title/Role**	**Experience in Current job/role**	**Type of Organisation**	**Year of Cloud service Deployment in Organisation**	**Workstations in Organisation**
34	Respondent57	Group A	IT Director	> 5 years	University	2012	> 500
35	Respondent59	Group B	***Project Manager***	> 5 years			
36	Respondent61	Group B	CEO	3-5 yrs			
37	Respondent64	Group A	Implementation Manager	3-5 yrs	University	2010	> 500
38	Respondent65	Group B	No Answer	1-3 yrs			
39	Respondent69	Group B	IT Consultant	> 5 years			
40	Respondent71	Group B	No Answer	3-5 yrs			
41	Respondent74	Group A	IT Manager	1-3 yrs	University	2012	> 500
42	Respondent75	Group A	IT Manager	1-3 yrs	University	2012	> 500
43	Respondent76	Group A	IT Manager	1-3 yrs	University	2010	> 500
44	Respondent77	Group A	Systems Administrator	1-3 yrs	University	2013	100-500
45	Respondent78	Group A	Systems Administrator	3-5 yrs	University	2012	> 500
46	Respondent80	Group B	IT Consultant	3-5 yrs			
47	Respondent81	Group B	No Answer	3-5 yrs			

Annexure D: Survey Questionnaire Form (Print)

The challenges in deploying IT services on Cloud Computing

All information collected in this survey is for PhD research study only. Collected data would be presented in aggregated form in future publications to ensure privacy. Your participation in this research is voluntary and you are free to withdraw your participation at any time.

The objective of this survey is to identify the challenges in the deployment of new IT services or migration of existing services on Cloud Computing within large-scale organisations. The questions focuses IT practitioners/Cloud deployment experts with experience in migrating/deploying IT services on Cloud Computing (Clouds) within their organisations or at client organisations.

You are requested to fill in this online survey and share your experiences in deploying IT services on Cloud Computing (Clouds). Participation in this research is voluntary and can be withdrawn. The summarised results of this survey will be shared with the respondents.

This survey is part of a research study conducted by Usman Nasir who is pursuing a Doctorate degree (PhD) in Software Engineering at Keele University, UK. Click http://goo.gl/vZQ18N for more information about this research project.

It takes approximately 15-20 minutes to answer all the questions of this survey.

Thank you for your participation,

Usman Nasir.

Candidate PhD CS,
School of Computing & Mathematics,
Keele University, Staffordshire,
ST5 5BG, United Kingdom.
[redacted]

There are 35 questions in this survey

Role

[]
Which of the following statement best describes (or closely describes) your job role, employer and experience in deploying or migrating services on Cloud Computing? *

Please choose **only one** of the following:

- ○ An IT Practitioner/ICT Teacher/IT Staff working at educational institution supervising/supporting Cloud Computing deployment
- ○ An IT Practitioner/Staff with experience in supervising/supporting Cloud Computing deployment in their organisation
- ○ Cloud Apps Developer/Trainer with experience in deploying Cloud Computing services
- ○ An IT consultant providing Cloud deployment services
- ○ An IT Practitioner/Staff employed by IT company that provides Cloud deployment services

[]
{if(G1_Q0001.NAOK == "EDU","What were the institutional goals /drivers / reasons for migrating IT services on Cloud Computing?", if(G1_Q0001.NAOK == "ORG","What were the organisational goals /drivers / reasons for migrating IT services on Cloud Computing?", "What are the client's goals /drivers / reasons for migrating IT services on Cloud Computing?"))}
*****

Please choose **all** that apply:

- ☐ Increase computing capacity and service performance.
- ☐ Gain flexible and scalable IT resources.
- ☐ Add redundancy to increase service availability
- ☐ Avoid capital expenditure (CAPEX)
- ☐ Bring diversification in IT systems
- ☐ Enhance disaster recovery capabilities
- ☐ Reduce IT's operational cost
- ☐ To overcome lack of staff capabilities
- ☐ Other: [ ]

[]
{if(G1_Q0001.NAOK == "EDU", "Did your institution achieve any significant reduction in software licensing fees or IT hardware costs after migration of services on Clouds?",if(G1_Q0001.NAOK == "ORG","Did your organisation achieve any significant reduction in software licensing fees or IT hardware costs after migration of services on Clouds?","Did the client organisations manage to bring about a significant reduction in software licensing fees or IT hardware costs after migration of services on Clouds?"))}

Please choose **only one** of the following:

- ○ Yes
- ○ No

[]

Which of the following institutional IT system is currently deployed on Cloud Computing? *

Only answer this question if the following conditions are met:
Answer was 'An IT Practitioner/ICT Teacher/IT Staff working at educational institution supervising/supporting Cloud Computing deployment ' at question '1 [G1_Q0001]' (Which of the following statement best describes (or closely describes) your job role, employer and experience in deploying or migrating services on Cloud Computing?)

Please choose **all** that apply:

- ☐ Student email
- ☐ Student data storage
- ☐ Staff email
- ☐ Staff data storage
- ☐ Virtual Learning Environment
- ☐ MIS (including Finance/Payroll/HR/BI)
- ☐ Records Management System
- ☐ IT Service Desk Management System
- ☐ Content Management System
- ☐ Other: [ ]

[]

Which of the following organisational IT system is currently deployed on Cloud Computing? *

Only answer this question if the following conditions are met:
Answer was 'An IT Practitioner/Staff with experience in supervising/supporting Cloud Computing deployment in their organisation ' at question '1 [G1_Q0001]' (Which of the following statement best describes (or closely describes) your job role, employer and experience in deploying or migrating services on Cloud Computing?)

Please choose **all** that apply:

- ☐ Email & Messaging
- ☐ Data Storage
- ☐ Finance
- ☐ HR
- ☐ Payroll
- ☐ Documents Management System
- ☐ Assets Management
- ☐ Learning Environment
- ☐ CRM
- ☐ Knowledge Management System
- ☐ Content Management System
- ☐ Business Intelligence
- ☐ Enterprise Web Portal
- ☐ Other: _____

[]

Is your institution/organisation considering or using the Cloud platform services (PaaS) or Cloud IT infrastructure services (IaaS/ITaaS)? What is the current status?

Only answer this question if the following conditions are met:
Answer was 'An IT Practitioner/ICT Teacher/IT Staff working at educational institution supervising/supporting Cloud Computing deployment ' *or* 'An IT Practitioner/Staff with experience in supervising/supporting Cloud Computing deployment in their organisation ' at question '1 [G1_Q0001]' (Which of the following statement best describes (or closely describes) your job role, employer and experience in deploying or migrating services on Cloud Computing?)

Please choose the appropriate response for each item:

	Completed the implementation	Implementation under way	Business case being developed	Considering options	No plans to use this service
Platform as a Service (PaaS)	○	○	○	○	○
Infrastructure as a Service (IaaS/ITaaS)	○	○	○	○	○

e.g: PaaS services: GoogleApp Engine, AzureCloud, AppHarbor, Cloud Foundry etc...
e.g: Infrastructure as a Service (Cloud Pro, Rack Space etc..)

Challenges & Practices 1

[]

Based on your experience of deploying Cloud Computing services, how strongly do you agree or disagree with each of the following issues as a challenge in deploying IT services on Cloud Computing.
*

Please choose the appropriate response for each item:

	1 - Strongly Disagree	Disagree	Neutral	Agree	5 - Strongly Agree	Not Sure
Difficulties in Application/Service migration to Cloud Computing	○	○	○	○	○	○
Incompatibility of existing IT Infrastructure/Resources for Cloud Computing	○	○	○	○	○	○
Increase in IT Dept's operational cost	○	○	○	○	○	○
Vendor /Service lock-in issues	○	○	○	○	○	○
Lack of interoperability between Cloud service or Cloud Vendors	○	○	○	○	○	○
Increased dependence on a third party provider	○	○	○	○	○	○
Decrease in service performance after migrating services on Cloud Computing	○	○	○	○	○	○
Lack of QoS or SLA monitoring solutions	○	○	○	○	○	○
Difficulty in determining Cloud Vendor's long-term viability or sustainability	○	○	○	○	○	○
IT Staff's resistance to change	○	○	○	○	○	○
Lack of client’s right to audit Cloud Vendors' services or security protocols	○	○	○	○	○	○
Legal or Compliance issues in migrating to or accessing Cloud Computing	○	○	○	○	○	○
Loss of control over IT resources after migration on Clouds	○	○	○	○	○	○
End-user resistance to change	○	○	○	○	○	○
Excessive effort is required to re-engineer legacy applications for migration on Clouds	○	○	○	○	○	○
Lack of sufficient migration support from Cloud Vendor	○	○	○	○	○	○
No indemnity for service failure by Cloud Vendor	○	○	○	○	○	○
Lack of organisational readiness	○	○	○	○	○	○

[]
Would you like to raise any issue(s) not mentioned in the above question that hampered deployment of IT services on the Cloud Computing?

Please write your answer here:

[]
Was the implementation of the Cloud Computing impeded due to end-users' resistance to change associated with using new technology?
***

Please choose **only one** of the following:

- ○ Yes
- ○ No

[]

Can you suggest any strategies or practices that can help to overcome the following issues in short span of time.

Example	
Issue	**Solution(s)**
Concerns on Cloud vendor's vulnerability to cyber attacks	**Sought security certification from Cloud vendor & shared it amongst stakeholders**

You can list your suggestions or share actions applied by you while deploying IT services on Cloud Computing.

Please write your answer(s) here:

Difficulties in Application/Service migration to Cloud Computing	
Vendor /Service lock-in issues	
Lack of interoperability between Cloud services or Cloud vendors	
Increased dependence on a third party provider	
Decrease in service performance after migrating services on Cloud Computing	
Lack of QoS or SLA monitoring solutions	
Legal issues in accessing Cloud Computing	
Lack of sufficient migration support from Cloud vendor	
Compliance issues in migrating to Clouds	
No indemnity for service failure by Cloud vendor	
Lack of organisational readiness	
{142281X136X4127}	

You can list one or more solutions for any particular issue.

[]
Based on your experience, what elements of IT infrastructure (OSs, Softwares, Networking Equipment, Hardware specs) you feel are essential for successful migration of IT services on the Clouds?

Please write your answer here:

Please list specific details (e.g 20MB internet access for 1000 user)

[]
{if((G1_Q0001.NAOK == "EDU" or G1_Q0001.NAOK == "ORG"),"The major concerns of the end-users at my institution/organisation regarding data and services hosted on Cloud Computing were", "The major concerns of the client organisations' end-users regarding data and services hosted on Cloud Computing were")}
***

Please choose **all** that apply:

- ☐ Availability of service/Cloud vendor
- ☐ Privacy of data stored on Cloud
- ☐ Reliability of services offered by Cloud Vendor
- ☐ Integrity of data hosted on Cloud
- ☐ Cloud vendor's vulnerability to cyber attacks
- ☐ Security concerns/apprehension about Cloud Computing
- ☐ Other:

[]

From your experience, which actions/practices helped in addressing end-users' concerns or changing their perception about the migrating existing IT services on Clouds?

Please write your answer here:

Any technique/approach/method/practice/tool kit/model etc.

Challenges & Practices 2

[]
While addressing end-users' concerns, which of the following approach was found effective or ineffective?
*****

Please choose the appropriate response for each item:

	Effective	Ineffective	Never applied
Focus Group Meetings	○	○	○
Dissemination Seminars	○	○	○
Informal Staff Meetings	○	○	○
Newsletters & Internal Branding	○	○	○
Change Champion Initiatives	○	○	○
Other approach(s)	○	○	○

[]
Which "Other approach(s)" did you find effective or ineffective?
*****

Only answer this question if the following conditions are met:
Answer was 'Effective' *or* 'Ineffective' at question '14 [G3_Q0001]' (While addressing end-users' concerns, which of the following approach was found effective or ineffective? (Other approach(s)))

Please write your answer here:

[]

Which of the organisational/departmental processes underwent any changes/transformation after deploying new IT services (or migrating existing IT services) to Cloud Computing?
*****

Please choose **all** that apply:

- ☐ IT communications process
- ☐ Procurement process
- ☐ IT financial approval process
- ☐ End-user IT account creation
- ☐ Vendor management process
- ☐ Feedback process
- ☐ No change in any process
- ☐ Any other:: [ ]

[]

{if((G1_Q0001.NAOK == "EDU" or G1_Q0001.NAOK == "ORG"),"Migrating IT service on Cloud Computing at my institution/organisation has", "Migrating IT service on Cloud Computing at client organisations has")}

Please choose **all** that apply:

- ☐ caused IT staff turnover
- ☐ forced IT dept to invest into IT staff trainings
- ☐ strengthened IT dept's authority
- ☐ changed IT organisational work patterns
- ☐ undermined IT dept's influence
- ☐ burdened IT staff with more work
- ☐ bred a sense of ineffectualness in IT staff

[]

Which of the following actions (or similar in nature) were carried out before migrating/deploying or launching the IT services hosted on Clouds? *

Please choose **all** that apply:

- ☐ Profiled service users, their service needs and utilisation patterns
- ☐ Developed plan for IT Organisation re-alignment with Clouds
- ☐ Assessed data sensitivity and criticality of work
- ☐ Assessed organisational-wide change impact
- ☐ Developed a systems migration/transition plan
- ☐ Assessed IT staffing and training needs
- ☐ Planned and executed Pilot Testing Project
- ☐ Developed an internal marketing plan for launching the Cloud based services
- ☐ Sought senior executive's support as sponsor or change champion
- ☐ Assessed end-user change impact
- ☐ Measured organisational climate for change readiness
- ☐ Assessed new IT resource needs (bandwidth etc.)
- ☐ Developed an integration plan for existing software/hardware
- ☐ Assessed IT Team change impact
- ☐ Developed end-user training plans
- ☐ Other action(s)

[]

Please briefly describe the action(s) that you have applied before migration or launching the Cloud Computing services?

Only answer this question if the following conditions are met:
Answer was at question '18 [G3_Q0005]' (Which of the following actions (or similar in nature) were carried out before migrating/deploying or launching the IT services hosted on Clouds?)

Please write your answer here:

[]
After roll-out of the migrated/deployed Cloud hosted services, which of the following actions (or similar in nature) were carried out.
*****

Please choose **all** that apply:

- ☐ Developed Cloud services quality feedback mechanism
- ☐ Updated IT Services Catalogue
- ☐ Removed old office software suites for all the end-users
- ☐ Measured the usage/uptake of Cloud hosted services
- ☐ Removed old office software suites for specific groups within end users
- ☐ Launched trainings to increase IT staff ‘s capabilities
- ☐ Other action(s)

[]
Kindly briefly describe the action(s) applied after roll-out of Cloud hosted services?

Only answer this question if the following conditions are met:
Answer was at question '20 [G3_Q0007]' (After roll-out of the migrated/deployed Cloud hosted services, which of the following actions (or similar in nature) were carried out.)

Please write your answer here:

[]

Which of the following trainings were provisioned for or provided to end-users?
*

Please choose **all** that apply:

- ☐ Online material/Intranet website
- ☐ Cheat sheets/hand-outs
- ☐ Hands-on training sessions
- ☐ Peer experience sharing
- ☐ No trainings were arranged
- ☐ Any other::

Grp A & B Institutional / Organisational details

[]
Choose the industrial segment your organisation is associated with
*****

Only answer this question if the following conditions are met:
Answer was 'An IT Practitioner/Staff with experience in supervising/supporting Cloud Computing deployment in their organisation ' at question '1 [G1_Q0001]' (Which of the following statement best describes (or closely describes) your job role, employer and experience in deploying or migrating services on Cloud Computing?)

Please choose **only one** of the following:

- ○ Agriculture/Forestry/Fishing
- ○ Construction
- ○ Manufacturing
- ○ Mining & Quarrying
- ○ Education
- ○ IT & Telecommunication
- ○ Health & Social work
- ○ Financial & Business services
- ○ Public Administration & Defence
- ○ Real Estate & Housing
- ○ Tourism
- ○ Transport
- ○ Wholesale & Retail
- ○ Other segment (Please specify) [ ]

[]
How would you classify the type of educational institution you work for?
*****

Only answer this question if the following conditions are met:
Answer was 'An IT Practitioner/ICT Teacher/IT Staff working at educational institution supervising/supporting Cloud Computing deployment ' at question '1 [G1_Q0001]' (Which of the following statement best describes (or closely describes) your job role, employer and experience in deploying or migrating services on Cloud Computing?)

Please choose **only one** of the following:

- ○ University
- ○ Higher Education Institution(HEI)
- ○ Further Educational Institution (FEI)
- ○ Other [ ]

[]
What was the year when IT services were migrated on Cloud Computing?
*****

Please write your answer here:

[ ]

[]
What is the total number of workstations managed by IT department across the whole institution/organisation?
*****

Please choose **only one** of the following:

- ○ less than 100
- ○ between 100 to 500
- ○ more than 500

[]

Which of the following standards have been implemented within the IT department (or across whole institution/organisation)?

Please choose **all** that apply:

- [ ] PRINCE2
- [ ] PRINCE2 LITE or variant
- [ ] FITS
- [ ] ITIL
- [ ] ITIL Lite or variant
- [ ] ISO27001
- [ ] Investors in People
- [ ] ISO20000
- [ ] Any other standard::

Grp C Client details

[]
Choose amongst the following industrial segments where you (or your company) have deployed IT services on Clouds?
*

Please choose **all** that apply:

- ☐ Agriculture/Forestry/Fishing
- ☐ Construction
- ☐ Manufacturing
- ☐ Mining and quarrying
- ☐ Education
- ☐ IT & Telecommunication
- ☐ Health & Social work
- ☐ Financial & Business services
- ☐ Public administration & Defence
- ☐ Real Etate
- ☐ Tourism
- ☐ Transport
- ☐ Wholesale & Retail
- ☐ Any other segment:: _____

[]
What is the average number of end-users at client organisations?
*

Please choose **only one** of the following:

- ○ less than 1000
- ○ between 1000 to 5000
- ○ more than 5000

[]

How often does your clients have the following standards implemented within their IT department or across the organisation?

Please choose the appropriate response for each item:

	Never	Rarely	Sometimes	Very Often	Always
PRINCE2	○	○	○	○	○
PRINCE2 LITE or variant	○	○	○	○	○
FITS	○	○	○	○	○
ITIL	○	○	○	○	○
ITIL Lite or variant	○	○	○	○	○
ISO27001	○	○	○	○	○
Investors in People	○	○	○	○	○
ISO20000	○	○	○	○	○
Other standards	○	○	○	○	○

[]
What did you have in mind when selecting "Other standards" in the above question?
*

Only answer this question if the following conditions are met:
Answer was 'Always' *or* 'Very Often' *or* 'Sometimes' at question '30 [G5_Q0003]' (How often does your clients have the following standards implemented within their IT department or across the organisation? (Other standards))

Please write your answer here:

Personal details

All information gathered by this survey is for research purposes only.

[]
Your name and contact details.

Please write your answer(s) here:

Full Name	
Institution/Company Name	
Email/Twitter/Website	

Collection of contact information in this survey is a research study compulsion.

[]
What is your current job title (or role)?
*****

Please choose **only one** of the following:

- ○ CEO
- ○ IT Director
- ○ IT Manager
- ○ Systems Administrator
- ○ IT Consultant
- ○ Implementation Manager
- ○ ICT Teacher
- ○ IT Support
- ○ Other tiltle

[]
How long have you been working in your present job (or role)?
*****

Please choose **only one** of the following:

- ○ less than a year
- ○ 1 to 3 years
- ○ 3 to 5 years
- ○ over 5 years

[]

Would you like to further participate in this research study by joining discussions or collaboration in case-studies and would like to be contacted in the future for this purpose?

Please choose **only one** of the following:

- ○ Yes
- ○ No

Thank you for your response. If you have any concerns or may wish to speak to the researcher(s) then please contact:

Usman Nasir - [redacted]

or

Dr Thomas Neligwa [redacted]

01.02.2015 – 06:20

Submit your survey.
Thank you for completing this survey.

Annexure E: ECAAM Form and Scoring Guide

Enterprise Clouds Adoption Assessment Model

Directions: Listed below are a series of statements about the readiness of your organisation to implement Enterprise Clouds for IT services. For each statement, please circle the number of the one response score that best reflects your personal opinion about your organisation's readiness to use Cloud services. Some of the statement have binary yes or no answer with specific scores. ***A "no opinion" option is provided for each statements, please select this if you feel that you have limited information about the statement.***

Sr.	Item Code	Statement	Key SD = Strongly Disagree, SA Strongly Agree						
			SD					SA	No opinion
1	EU-01	Vision document detailing Cloud migration goals is shared with all employees	1	2	3	4	5	6	0
2	IC-06	Vendor Management processes are updated to accommodate Clouds services.	1	2	3	4	5	6	0
3	EU-02	Staff members are clear about objectives behind migration of IT Services on Clouds	1	2	3	4	5	6	0
4	EU-03	Staff members always feel free to ask questions and express concerns about IT related issues.	1	2	3	4	5	6	0
5	EU-04	Employees are kept well informed about IT services thru formal/informal communication channels	1	2	3	4	5	6	0
6	EU-05	Senior executive is nominated as change champion to engage with employees in dissemination activities related to Clouds	1	2	3	4	5	6	0
7	EU-06	Staff frequently share their technical knowledge or new technical ideas with others staff members	1	2	3	4	5	6	0
8	EU-07	Some staff members are willing to try new ideas even if others are reluctant	1	2	3	4	5	6	0
9	EU-08	Employees have a positive attitude toward Clouds implementation	1	2	3	4	5	6	0
10	EU-09	Employees are provided with online resources to learn on their own pace	1	2	3	4	5	6	0
11	EU-10	Multiple hands-on trainings sessions are planned to train staff to use/apply Cloud services in their work	1	2	3	4	5	6	0
12	EU-11	A survey was conducted from employees asking their preference about type of training they prefer for Clouds	1	2	3	4	5	6	0
13	IC-07	There is less likelihood of IT staff leaving their jobs because of Clouds services	1	2	3	4	5	6	0
14	IC-08	IT staff is given trainings to learn new skills to support Clouds	1	2	3	4	5	6	0
15	EU-12	Staff training and continuing education are priorities here	1	2	3	4	5	6	0
16	IC-09	Executives have defined new roles and responsibilities for IT staff after Clouds	1	2	3	4	5	6	0
17	EU-13	There is an emphasis on the collaborative/interdisciplinary teams to train staff to use Cloud services.	1	2	3	4	5	6	0
18	IC-10	IT staff are given incentive to work with newly changed work patterns	1	2	3	4	5	6	0
19	IC-11	There are enough IT staff to meet current support needs.	1	2	3	4	5	6	0
20	EU-14	Employees are made aware of Cloud vendor's data security capabilities and certifications	1	2	3	4	5	6	0
21	EU-15	Employees are aware about data storage location and its transmission across Cloud services	1	2	3	4	5	6	0
22	EU-16	Employees are aware of IT services on Clouds and impact of any disruptions.	1	2	3	4	5	6	0
23	EU-17	Employees are clear about data ownership and their responsibilities towards Cloud storage	1	2	3	4	5	6	0
24	EU-18	Employees know the maximum tolerable period for disruption of Cloud services and time required for service resumption	1	2	3	4	5	6	0
25	EU-19	Policies and procedures for data retention, deletion and storage on Clouds exist and known to all employees	1	2	3	4	5	6	0
26	EU-20	Employees are encouraged to use encryption for sensitive data stored on Clouds	1	2	3	4	5	6	0
27	EU-21	Employees are provided with Service quality statistics and performance monitoring data of Cloud services	1	2	3	4	5	6	0
28	IC-12	Executives are aware of future staffing needs for supporting Cloud services	1	2	3	4	5	6	0
29	IC-02	The implementation team have support and resources required for the project.	1	2	3	4	5	6	0
30	EU-22	Executives have talked with employees about their concerns regarding Cloud services	1	2	3	4	5	6	0

More statements on next page

Sr.	Item Code	Statements	Key SD = Strongly Disagree, SA Strongly Agree						
			SD					SA	No opinion
31	IC-03	Implementation team members would share responsibility for the success of this project.	1	2	3	4	5	6	0
32	IC-04	Current IT Staff are taken as important part of implementation team	1	2	3	4	5	6	0
33	EU-23	IT Executives engage employees in informal meetings to discuss new Cloud services	1	2	3	4	5	6	0
34	IC-01	Clouds implementation plan is developed with inputs of current IT staff	1	2	3	4	5	6	0
35	IC-05	Executives have identified IT processes that would be changed after Clouds and plan to transform them first	1	2	3	4	5	6	0
36	L-01	Independent IT/Cloud system audits to test compliance would be held annually	1	2	3	4	5	6	0
37	L-02	Information Security policies/procedure are updated for Cloud services Regulatory/Statutory compliance	1	2	3	4	5	6	0
38	L-03	Cloud vendors are asked to demonstrate compliance with applicable laws & security certifications	1	2	3	4	5	6	0
39	L-04	Clouds vendor is asked to use data centers within the required legal jurisdictions.	1	2	3	4	5	6	0
40	L-05	Cloud vendor's service agreement are drafted, vetted and approved by Legal department/Lawyers	1	2	3	4	5	6	0
41	L-06	SLA with Cloud vendor has clauses about data confidentiality & security	1	2	3	4	5	6	0
42	L-07	Employees are aware of their legal responsibilities while using Cloud services	1	2	3	4	5	6	0
43	L-08	User's explicit consent is solicited if the data storage is non-compliant with laws/rules etc.	1	2	3	4	5	6	0

Sr.		Statements	No	Yes	No opinion
44	T-01	A pilot deployment was conducted to see operational feasibility	0	6	0
45	T-02	An assessment of data sensitivity & criticality of work was carried out before Cloud decision	0	6	0
46	T-03	Network bandwidth need assessment based on users, locations & types of IT services was carried out for Cloud services	0	6	0
47	T-04	Highly interconnected Systems are not migrated on Clouds	0	6	0
48	T-05	Technical audit was conducted to investigate Clouds and System integration issues for existing applications	0	6	0
49	T-06	Vendor's reseller/partners would be used to migrate Application/Services on Clouds	0	6	0
50	T-07	We would use http/https APIs or open source APIs for Cloud services	0	6	0
51	T-08	Middleware compatible with multiple Clouds would be used to avoid Vendor lock-in risk	0	6	0
52	T-09	System would be duplicated on a second Cloud service as a stand-by node	0	6	0
53	T-10	Clouds vendor's performance was investigated before migration for future performance baseline	0	6	0
54	T-11	Service quality monitoring tools are deployed outside the Cloud for Cloud performance monitoring	0	6	0
55	T-12	Cloud services performance KPIs are developed/used to monitor quality of Cloud services	0	6	0
56	T-13	A new feedback mechanism for Cloud service has been provided to end-user to note their feedback	0	6	0
57	T-14	Secure communication protocols and multi-factor authentication are used in accessing Cloud services	0	6	0
58	T-15	Cloud Vendor's suggestion/guidelines on security and authentication are strictly followed.	0	6	0
59	T-16	Good quality third party/vendor support is available for technical issues in migration of services on Clouds	0	6	0
60	T-17	We use/subscribe premium support from Cloud vendor	0	6	0

Enterprise Clouds Adoption Assessment Model
Scoring Guide & Results

Directions: Scoring can be done by one single adminstration or by summing up all the forms and averaging the values for each item.

	Dimensional Score	Readiness level for adoption of Cloud services
Technical Readiness (Sum of all items with code T divided by 102, rounded up to nearest digit)		<5 Poor 5-7 Fair , >7 Good
Legal & Compliance Readiness (Sum of all scores with Code L divided by 48, rounded up)		<5 Poor 5-7 Fair , >7 Good
IT Capabilities Readiness (Sum of all items with code IC divided by 72, rounded up)		<5 Poor 5-7 Fair , >7 Good
End-User Readiness (Sum of all items with Code EU divided by 138, rounded up to nearest digit)		<5 Poor 5-7 Fair , >7 Good
Total score all statements		
Overall readiness percentage (Total score of all items divided by 360)	%	< 50% overall poor readiness, 50% to 60% Fair, > 60% Higher level readiness

Annexure F: Ethical Approval

Keele University

RESEARCH AND ENTERPRISE SERVICES

3 February 2012

Mr Usman Nasir
Room 2.25
McKay Building

Dear Usman

Re: 'Enterprise cloud adoption assessment model'

Thank you for submitting your revised project for review.

I am pleased to inform you that your project has been approved by the Ethics Review Panel.

If there are any other amendments to your study you must submit an 'application to amend study' form to Michele Dawson. This form is available from Michele (01782 733588) or via http://www.keele.ac.uk/researchsupport/researchethics/

If you have any queries, please do not hesitate to contact Michele Dawson in writing to m.dawson@uso.keele.ac.uk

Yours sincerely

M. Dawson

pp **Dr Roger Beech**
Chair – Ethical Review Panel

CC RI Manager

Research and Enterprise Services, Keele University, Staffordshire, ST5 5BG, UK
Telephone: + 44 (0)1782 734466 Fax: + 44 (0)1782 733740